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In addition to the above, the important contributions of the many family health workers, field investigators, statistical staff, administrators and support staff are gratefully acknowledged.

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CHAPTER 1

THE PROBLEM AND THE EVIDENCE

Carl E. Taylor, Arnfried A. Kielmann, Cecile De Sweemer and Dov Chernichovsky

The Social Burden of Malnutrition and Infection

The distribution of childhood malnutrition and infection around the world reflects local patterns of poverty. The moral and political justification for equity in meeting basic human needs includes growing realization that the continuing flagrant neglect of health care for children must not continue. National and international policy is beginning to be influenced by pragmatic awareness that optimum development of children represents society's greatest resource for the future. The research reported here provides hope that direct and practical measures can be applied to correct existing inequities in the health and nutritional care of children.

As many as 25 percent of the children in some developing countries die before they reach age five. The social costs of childhood malnutrition and infections show up not only in high death rates but even more as long term deficits in those children who survive. Children in developing countries may have an average of up to 160 days of illness each year, with 3-4 episodes of diarrhea and 4-5 illnesses due to severe respiratory infections[1,2,3]. Nutritional deficits and associated lack of stimulation in early life interfere with both physical and mental growth[4,5]. As a consequence, the potential reduction throughout adult life in productivity and physical output represents a major limitation on human resources.

The two-way interactions between socioeconomic development and nutritional status include the multiple effects of child mortality on population growth. People improve the care and condition of their children as soon as socioeconomic conditions permit and this leads to a reduction in childhood mortality. The most rapid population growth has resulted from imbalance in birth and death rates during periods when mortality declined spontaneously and moderately, but fertility remained high. This imbalance is maintained for protracted periods when the poor do not receive equitable coverage by health care and other social services, even though the affluent segments of society may enjoy rapid economic development. By contrast, recent experience in an increasing number of developing countries suggests that by promoting mortality decline among the poor as part of overall social development, conditions will be created which offer the best chance of bringing fertility down to levels consistent with optimum population growth. This in turn should improve socioeconomic conditions.

Some efforts have been made to quantify investment in children in economic terms[6]. Child death in developing countries is, however, so ubiquitous that it seems to be taken for granted by parents who act as though having children essentially entails no cost. Another mouth to feed is not considered a major concern in comparison with the potential of adding another family member who might become economically productive. We know little about the emotional investment and sense of loss when a child dies. Under conditions of high mortality this may be accepted as a part of life beyond the parents' control but important changes in attitude occur when people begin to feel that they can gain control over their own and their childrens'

future. Although it is harder to measure, the non-economic benefits of reducing child death rates probably include a reduction in fatalistic attitudes as awareness develops that both parents and children have increased years of healthy life to look forward to.

Background Information on Synergism Between Malnutrition and Infection

Throughout history and around the world, the leading cause of death, disease and retarded growth and development in children has been synergism between nutritional deficiencies and common childhood infections. Lack of recognition of this relationship resulted from the tendency of research workers to seek for single causes and to base scientific advance on increasingly narrow analytic definitions of problems. In the past two decades major advances in understanding of the interactions between malnutrition and infections emerged from a synthesis of several different channels of investigation[7,8,9]. The underlying biologic principles have now been clarified sufficiently to provide a better basis for policy setting and for action in control programs, and policy formulation.

For many years nutrition research workers reported on problems that arose when infections intervened in nutritional studies and considered it a nuisance that carefully nurtured deficiencies in laboratory animals were distorted by intercurrent infections. Then as their frequency and importance became recognized it was realized that many infections could be controlled by providing better nutrition. Infection control has become one of the justifications for nutrition programs.

Similarly, scientists studying infections found their results seriously compromised by what was happening to patients or laboratory animals nutritionally and conversely that infections often precipitated malnutrition.

The recognition emerged that unless nutritional status was controlled in experiments, the manifestations of infections were likely to be confounded. The care of diseases such as typhoid and tuberculosis was revolutionized when it was found that any kind of fever caused massive protein loss[10], and that maintaining nutritional status was essential for good care. More importantly, it was recognized that infections frequently precipitated malnutrition in children, for instance, epidemics of kwashiorkor followed epidemics of measles[11]. Progressive accumulation of such observations led to claims among infection control specialists that a primary justification for their programs was to prevent malnutrition. The complex ecology of the interactions between malnutrition and infections have been reviewed by: Scrimshaw, Taylor and Gordon[12, 13]; Burgess and Dean[14]; Taylor and De Sweemer[15]; and Taylor, Kielmann and De Sweemer[16].

It is now known that common infections precipitate malnutrition, which in turn reduces resistance; this facilitates further infections which again lead to increased nutritional deficit. If the sequence moves rapidly the patient dies although neither malnutrition nor the infections by themselves would have caused death. When the sequence proceeds at a slower pace the combination is the major cause of chronic growth deficit, both physical and perhaps mental, in the more than 200 million deprived children in the world. These problems are most prevalent in developing countries where most of the world's children live.

The gradually increasing awareness of interactions between infections and malnutrition has been accompanied by a great deal of research on possible mechanisms. Both antibody and cell-mediated immune responses as the major protections against infection, are seriously compromised by protein-calorie

malnutrition and by specific deficiencies which have selective effects on particular immune mechanisms. A wide range of natural barriers which provide natural resistance to infections such as the integrity of the skin and mucous membranes, normal physiology of the bowel, etc., are also selectively modified by specific nutritional deficiencies.

Conversely, particular infections and the related response mechanisms of the body have been found to cause deterioration in nutritional status in diverse ways. Most marked are direct increases in calorie consumption and the tissue destroying catabolic effects of fever with protein loss. A complex chain of hormonal stress-related mechanisms causes direct interference with cell building anabolic activity. Intracellular infections destroy or coopt the functions of cells. Other more general mechanisms are equally important; for instance, fever may cause loss of appetite and diarrhea may interfere with intestinal absorption of nutrients. These effects are aggravated by social taboos in many societies imposing starvation diets during fever or diarrhea.

Nutritional demands are highest in early childhood during rapid growth. The birth weight of a normal infant doubles in six months, triples in one year, and quadruples in two years. Good nutrition is well maintained by breast feeding during the first six months. Breast feeding continues into the second year, generally with inadequate supplementation and then the child usually goes directly to an adult diet without appropriate transitional weaning foods.

Infectious diseases are relatively uncommon during breast feeding while the child is protected by passively acquired maternal antibodies and minimal

exposure to infections. As the baby becomes more mobile and takes foods in addition to breast feeding the prevalence of infections become extremely high during the second half of the first year and the second year. As immunity develops the prevalence of infections progressively declines[17].

High nutritional demand coincides with frequent infections. The infection increases nutritional requirements and the malnutrition predisposes to infections.

The problems of the first several years may be compounded if the baby does not get a good start at birth. The newborn may suffer from prenatally acquired infections[18]. Low birth weight and inadequate nutritional reserves from a malnourished mother can be even more serious. Children born with a decisive handicap in nutritional or infection status have special difficulty in catching up to their genetic growth potential on a food intake that is marginal. In rural Guatemala most deaths in the first year of life were in children with low birth weight[19].

Combinations of interactions frequently occur in well-defined patterns under natural conditions. An acute childhood disease (such as measles or whooping cough) in well-nourished children causes minimal and temporary disability; but in children with borderline malnutrition similar infections may precipitate kwashiorkor[20] or the acute manifestation of specific deficiencies such as blindness from avitaminosis A [21]. The relatively large caloric and nutrient requirements needed to recover from specific illnesses are considerably more than what is usually available to children in developing countries[22].

In spite of these clear cut relationships, research and the organization of control programs against these two major problems has almost always been separated. The Narangwal Nutrition Study summarized here is a major step forward in moving from the new understanding about synergism between malnutrition and infections to practical policy and programs.

Prior Field Trials

Most child nutrition programs currently place major emphasis either on nutrition rehabilitation centers which treat children severely ill with marasmus and kwashiorkor or on mass programs for feeding school children. Rehabilitation programs tend to be so expensive that there is increasing doubt about their cost/effectiveness. In 1966, McLaren in Beirut demonstrated that it took four months of care at a cost of at least $1,000 to rehabilitate one marasmic child; one third of these children died within six months[23]. Such an expense for children who are brought for care at late stages of nutritional deterioration clearly is not a means of meeting mass need. The second alternative is mass feeding programs but they do not usually reach the preschool children who are in greatest need or the poorest children who do not go to school.

Ways must be found to recognize and treat malnutrition early and as near to the home as possible. It is especially important to change basic patterns of child care in the home through nutrition education, ensuring the availability of food, personal hygiene and general health education. Since synergism between malnutrition and infections is more important than either condition alone they both need to be studied and cared for together.

Between 1955 and 1960 the first major epidemiological study of the interrelations between malnutrition and infections was carried out as an ancillary study of the Khanna Population Study in the Punjab (India) only 35 kilometers from Narangwal[24]. A detailed longitudinal survey of numbers and causes of death showed an age specific death rate for children less than one year old of 156 infant deaths per 1,000 livebirths. The neonatal death rate was 74 and the postneonatal death rate was 82 per 1,000 livebirths. For 1-4 year old children the mortality rate was 27 per 1,000 population. During the second year of life mortality remained very high with 72 deaths per 1,000 population.

Weaning diarrhea was identified as the major cause of death in children and the general pattern of its interaction with marasmus was defined[25]. Mortality rates varied considerably by season with overall crude death rates being highest in May and June (21.1 per 1,000 population) and lowest during the winter months (14.5 per 1,000 population). The causes of childhood deaths varied with the seasons. In general, deaths from diarrheal diseases predominated in May, June, October and November and deaths from pneumonia in December, January and February. The Khanna data showed that child mortality from infectious diseases was highest when associated with malnutrition[26] for all age groups up to five years of age.

In 1959 the first major field study to try to modify experimentally the variables influencing the interactions between malnutrition and infection was organized in the Guatemalan highlands[27]. The research design provided for comparisons between three villages with differing service inputs. The following services were provided: (1) nutritional supplements for all children in one village; (2) medical care by a doctor and a fairly complete

health team and improved water supply and a latrine program in the second village; and (3) the third village was a control. Over a five year period growth, morbidity and nutritional status of all the children in these village communities were observed. The study contributed numerous valuable discoveries regarding the ecology, extent, nature and manifestations of malnutrition and infectious disease in a rural Guatemalan preschool child population. The specific contributions of the interventions can be summarized as follows:

In the nutrition supplementation village, infant mortality declined more than expected on the basis of trend lines established over the five years preceding introduction of services. Neither of the other villages (medical care and environmental sanitation or control) showed a greater than expected decline in infant mortality. One-to-four year mortality was reduced in all three villages, with the largest decrease occurring in the nutrition supplementation village, the next largest in the medical treatment and sanitation control village, and the least in the control village[28]. Only the largest of these differences was statistically significant.

Children in the nutritional supplementation village showed a statistically insignificant though consistent improvement in linear growth and weight gain as compared with those in the medical treatment and sanitation villages. There was no apparent effect on morbidity experience other than an inverse relationship between feeding center attendance and morbidity experience in the feeding center villages. The medical treatment village experienced the highest morbidity with 4.4 illnesses per year, while the control and nutritional supplementation villages had relatively low rates with 2.0 and 2.4 illnesses per child per year. However, these results were markedly influenced

by a diarrheal disease epidemic which twice during the five years struck the medical treatment village but not the other villages. Differential reporting may also have influenced the morbidity results, since it was demonstrated at Narangwal that more illness tends to be reported where treatment is provided.

Although results from this Guatemalan experiment clearly indicate some beneficial effects, especially from the child feeding program, the relative contribution of curative, preventive and nutritional services to child health and their optimal mix remained unclear.

Purposes Underlying the Research

The general policy issue underlying the Narangwal study was to determine whether there is a synergism of programs to control malnutrition and infections similar to the known synergism between these problems. Specifically, we planned to measure the relative strength and dynamics of both sets of interactions.

The more specific policy questions which led to this study were: can nutrition interventions reduce the incidence, duration, and impact of infections? Can infection control improve nutritional status? Is there a synergism in program effects so that a combined nutrition and infection control program will have greater impact on cost/effectiveness than would be expected from each program alone? Finally, can better field programs be developed to combine the most cost/effective malnutrition and infection control measures so that they can be implemented within the personnel and financial constraints of developing countries? The ultimate practical purpose is to improve knowledge and methods that can be applied in programs to improve the health and nutrition status of the millions of children who have been underserved.

THE NARANGWAL EXPERIMENT

The Narangwal Setting

The Nutrition Project was one of a number of studies carried out at the Narangwal Rural Health Research Center located in Ludhiana District, Punjab. This research center was a research, training and demonstration area developed collaboratively by the Indian Council of Medical Research, the Punjab Directorate of Health and Family Planning, the Johns Hopkins University Department of International Health, the Ludhiana Christian Medical College, The All India Institute of Medical Sciences, the Chandigarh Postgraduate Institute of Medicine, and other academic and research institutions in India. Funding for this research was obtained from the Indian Council of Medical Research (ICMR), World Health Organization (WHO), National Institutes of Health (NIH), and the Agency for International Development (AID).

The first project at Narangwal was started in 1961 jointly with the Ludhiana Christian Medical College and six other Indian medical colleges to study the rural orientation of interns and physicians[29]. Subsequent projects included a study of primary health centers based on functional analysis of health needs and resources[30], and studies of beliefs and practices of village people in relation to diet and disease[31]. A major field study on the integration of health and family planning services was conducted in parallel with this nutrition project and results are being analyzed[32]. During the field work phase of the latter project and the nutrition project there were more than 150 project staff including family

health workers, public health nurses, physicians, statisticians, social scientists, and field investigators working together on the various projects. All of these were Indian except for an average of two Hopkins faculty members About one-third of these project staff members worked primarily on the nutrition study. All personnel lived in village homes near the project headquarters except for the family health workers who resided in their study villages. These accommodations were made hygienically safe by simple improvements. There were tremendous advantages in sharing the lives of the village people, both in gaining their acceptance and in improving the staff's understanding of village life. The total population covered in the parallel nutrition and population projects was about 35,000 people living in 26 villages distributed around three community development blocks.

The research project headquarters in Narangwal village was also in village houses which were converted to provide office space for investigators, statistical staff, supervisors and administrators; storage for records, research forms, drugs, supplies and equipment; library; classrooms; field laboratory; and a workshop supporting the renovation and maintenance of village housing for clinics and residences and for maintaining equipment and vehicles.

The ten study villages in the nutrition project were selected in clusters of two to three villages scattered around two community development blocks. During their selection, particular efforts were made to get reasonable comparability between the different groups of villages in terms of major socio-cultural and economic indicators. An effort was also made to maintain sufficient separation between village clusters to minimize communication

among villagers about differences in services packages. To avoid the problem that arose in the Guatemalan study when outbreaks of diarrhea seriously affected intervillage comparisons, we decided to include at least two villages in each experimental or control group. An important part of the selection process was to assess the potential level of cooperation in each village and negotiate with the villagers until they were willing to accept whatever combination of service interventions was assigned to their village in the research design. In this negotiation it was made clear that there would be no compulsion for families to cooperate with the particular set of services that would be provided in their village. All village leaders, however, agreed without reservation to help persuade all families to participate in all of the survey and measurement activities that were necessary for this to be an effective research enterprise.

During June 1967 prior to the start of the experimental service programs a preliminary anthropometric survey of 391 children between the ages of 0-5 years was carried out in our study villages[33]. Sixty-two percent of children between 7-12 months of age and 82 percent between 13-24 months fell below the Harvard third percentile for weight. Overall, almost 50 percent of children 0-5 years of age fell below the third percentile of the Harvard weight-for-age standard. On clinical examination 24 percent of children had growth retardation in height, 18 percent had reduced subcutaneous fat, 13 percent had reduced muscle mass, and 2 percent were severely marasmic. These data suffer the bias of a point prevalence survey in that they indicate the nutritional status at one point in time which happened to be the most difficult time for children during the hot and dry harvesting season from mid-April through June, when morbidity and mortality are highest.

Neumann et al[34] also reported the results of a pilot longitudinal morbidity study in Narangwal villages in 1967 which showed a high load of infectious diseases in children including respiratory illness episodes averaging 4.0 per child per year, diarrhea episodes 2.7 and eye infections 1.2 per child per year.

The nutrition villages received the following service packages: nutrition care (NUT), health care mainly concentrating on infection control (HC), integrated services for both (NUTHC) and control (CONT-N). Figure 1.1 shows the experimental design of both the nutrition and population projects. The study population of children up to three years of age in the ten villages averaged approximately 1,000 with each experimental group having an average of 200-300 children 0 to 3 years of age at any time. Figure 1.2 shows the location of these villages along with the study villages of the parallel population project.

The Punjab Setting

Narangwal and the study villages are in Ludhiana District in the heart of the predominantly agricultural Punjab, an area that benefited dramatically from the "Green Revolution" immediately before and during the project. About 80 percent of the land is under irrigation from canals and tubewells. The combination of abundant water, fertile soil, rapid introduction of high-yield hybrid wheat strains and other improved crop varieties, intensive use of fertilizer, selective mechanization and implementation of modern farming techniques, together with the assertive character of the Punjabi population has led to phenomenal economic progress. The per capita income was approximately $150*, compared with approximately $90 for the rest of India. According

* During the period of the study, the exchange rate averaged approximately Rs 7.5 to the U.S. dollar.

Figure 1.1

Distribution of Villages According to the Experimental Design of Both Nutrition and Population Studies

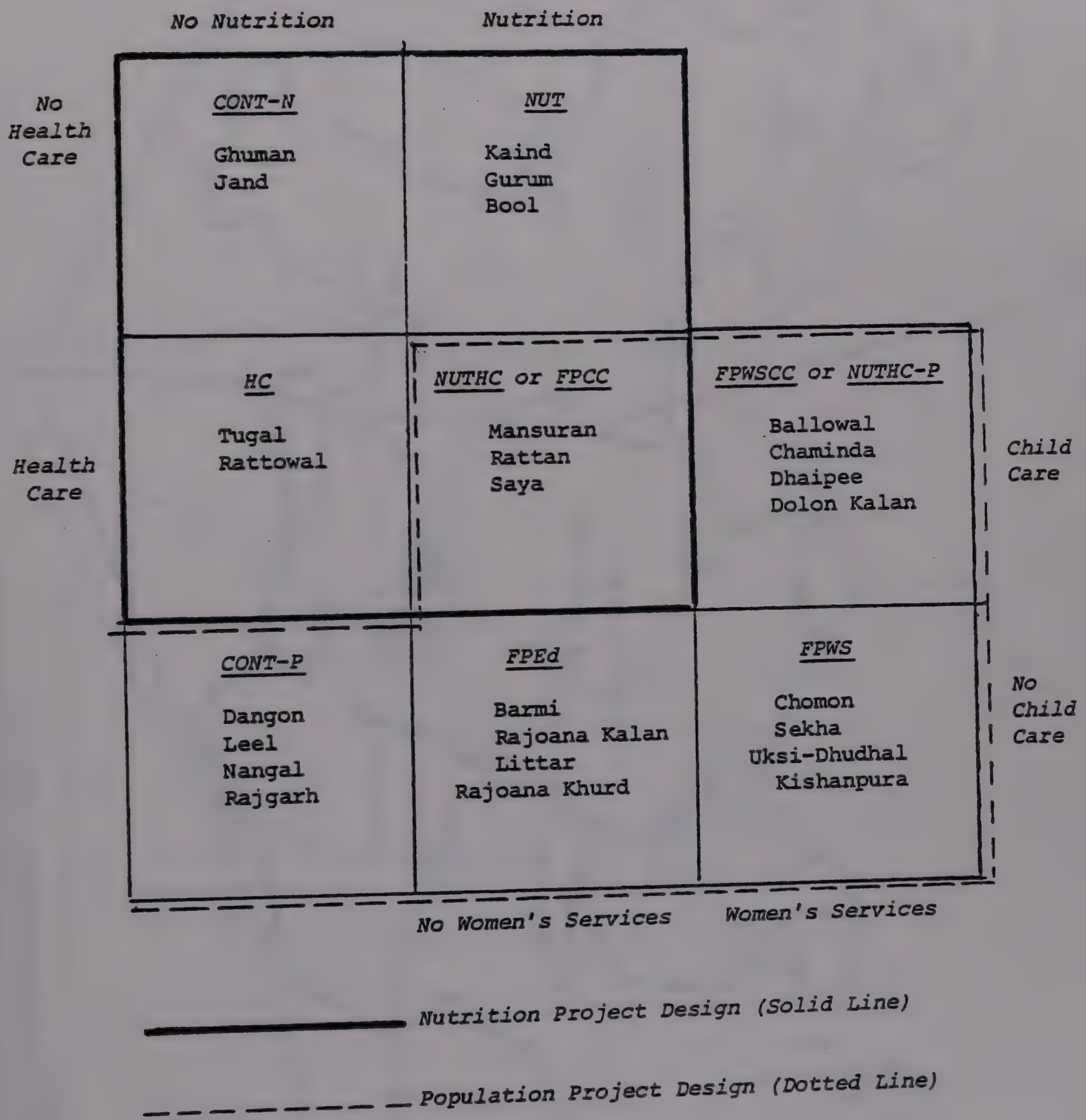
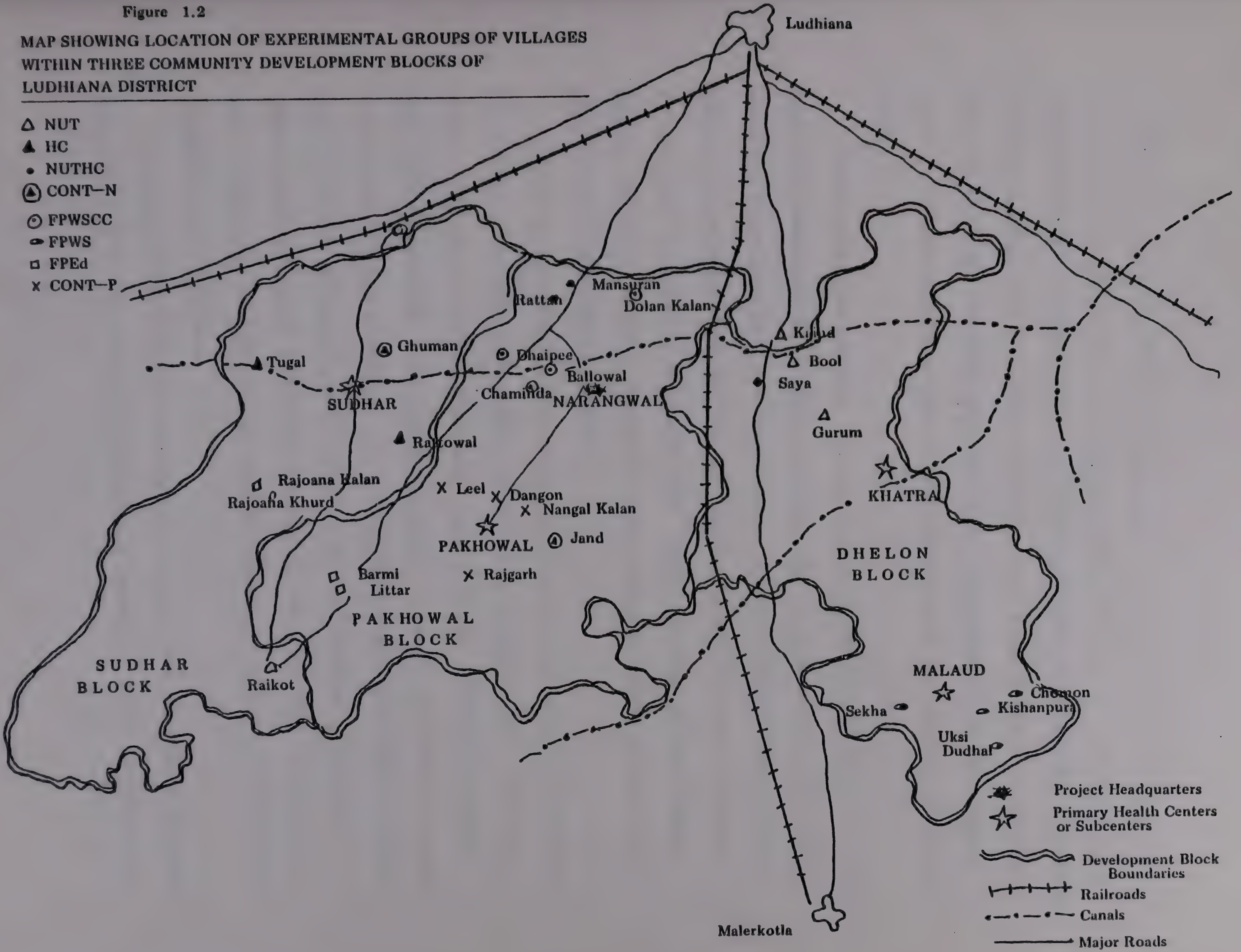


Figure 1.2

MAP SHOWING LOCATION OF EXPERIMENTAL GROUPS OF VILLAGES WITHIN THREE COMMUNITY DEVELOPMENT BLOCKS OF LUDHIANA DISTRICT



to the 1971 census, Punjab had a population of 13.4 million, 67 percent living in rural areas, with the high population density of 176 persons per square kilometer. According to a 1968 sample registration survey, 13 percent of the population was less than five years old. Sixty percent of the population are Sikhs and the rest are Hindu (38%), Christian (1.2%) and Muslims (0.8%). The largest proportion of Sikhs are Jats of the warrior (Kshatrya) caste.

The Punjabis are probably the best nourished of India's population groups. Their diet based mainly on wheat, milk and dal (pulse) is good. Two main crops are grown yearly: the "rabi" harvest in May and June which is primarily winter wheat, and the "kharif" harvest in the fall which produces a wide range of products including corn (maize), millet, pulses, cotton, peanuts and rice. In both seasons a large amount of fodder is grown for milk buffalos and draught animals.

Dramatic improvements have occurred in many areas of life. Education has spread so rapidly that every village has a primary school. Secondary schools are within cycling distance. Some villages, including Narangwal with 1,800 population, have degree colleges. Probably more than 70 percent of children are now in school. In 1969 approximately 75 percent of women and 54 percent of males aged 15 or older were illiterate. The rapid generational change is indicated, however, by the fact that in the same year, of persons 5-15 years old, only 45 percent of females and 37 percent of males were illiterate.

Transportation has also increased as villages are now linked by paved roads instead of mud tracks for oxcarts as formerly. Buses run regularly

along numerous routes from Ludhiana. Increasingly village streets are paved and the perpetual mudholes from village drainage are disappearing. Basic sanitation has changed for the better. According to our socioeconomic survey, 80 percent of homes now have reasonably safe handpumps in the courtyard, albeit for convenience and time saving rather than for health reasons. Change is not complete since latrines are still rare and flies swarm as always. But housing is improving as an early response to local affluence.

One of the key questions in this study has been why is there so much malnutrition in an area with an abundant food surplus. Punjabis have the reputation of being the tallest, strongest and hardest working of India's many cultural groups. The "typical" well-nourished Punjabi is the Jat farmer who owns and farms his own land. Even among Jat farmers the nutritional status of adults does not always predict the nutrition of their children. About one-third of the villagers are from the lower castes who work mainly as farm laborers and the prevalance of malnutrition among their children is particularly high.

Planning the Experiment

From 1969 through May 1973 the Narangwal Rural Health Research Center conducted this field experiment in ten villages. Prior preparatory work started in 1967 and lasted for almost two years including: preliminary surveys of anthropometric status and morbidity; selection of study villages; standardizing methods for data collection and health services; training staff; and most importantly, developing good cooperative relationships with the local populations. The data collected from 1969 to 1973 reflect a relatively stable field activity and are the basis for this analysis.

As indicated above, this was a period of extremely rapid socioeconomic development in the Punjab and an important question is whether this changing environment influenced our research findings, their general applicability, and their meaning for practical health programs in India. The research design was structured so that inter-village differences would provide valid comparisons. Dramatic economic and social changes were evident in all the villages and therefore the demonstration of significant differences between groups should have even greater scientific validity because they were demonstrable even in the presence of general economic development. Interactions and causal relationships can be interpreted within the experimental design since most non-program variables were controlled for.

We recognized from the beginning that this research would not provide the final answer in terms of what could be implemented directly in all parts of India since economic levels, cultures and local ecologies varied greatly. These research findings need to be adapted and applied in demonstration projects under different conditions and within the constraints of available services in each part of the country. Appropriate combinations of services can then be evolved to fit local situations.

The relevant question, then, is whether the measures which were found to be effective as experimental inputs in our research design would be effective only in situations with rapid general development. This query can be answered only by research under other appropriate situations. Since the rural areas of most developing countries are entering periods of rapid development such as has occurred in the Punjab, although perhaps less dramatically, we feel that the Narangwal findings will have most meaning for areas experiencing such change. Our intuition suggests, however, that it

may be possible to demonstrate significant effects even more dramatically in less developed areas because the nutrition and infection problems are greater. A real challenge in such situations is to see if an integrated package of child health care, maternal health care, nutrition and family planning can become an entering wedge in the process of development.

In order to conduct studies on these complex and basic questions there was need for a reorientation of research thinking. Experiments on synergism in laboratories have been done by introducing an agent and a particular deficiency and observing effects directly. Once the basic biological relationships have been worked out in laboratory studies the crucial question remains how do these findings apply to humans? Some evidence on specific interactions between malnutrition and infections has been obtained from clinical observations of patients who are already sick. But to investigate these interactions epidemiologically is substantially more complicated. The usual epidemiological field study falls methodologically short because it tends to focus on single problems even though viewed in the total ecology of the community. The need here was to observe multiple health problems simultaneously.

The only ethical way of studying these problems in human populations is to find groups with a high prevalence of both malnutrition and common infections and then observe what happens when there is selective reduction of each type of condition. The research design should permit measurement of all parameters in the interaction as particular conditions are eliminated or reduced. This meant that controlled studies of comparable population groups had to be structured so that each group would receive a different service input. Through open discussion these decisions would have to be agreed to by the populations studied. Local officials would also have to agree that this kind of selective intervention was ethically justified.

In the methodology chapter some ways that were developed to monitor these ethical concerns are described.

Because we were primarily interested in services to control the overall effects of malnutrition on the one hand, and infections on the other, it was essential that the research design combine interventions against each grouping of conditions into simple service packages. The data gathering had to have a sufficiently sound epidemiological base so that we could also sort out the specific effects of individual interventions within the broad service groups.

The most important ethical aspect of designing this experiment was recognition that the pure research objectives had to be kept in balance with the parallel set of service objectives which are specified in the methodology chapter. While getting basic scientific information on particular interactions we insisted that anything we did should have immediate applicability and should contribute to the health care of the village children being studied. No intervention would be tried which could not conceivably be fitted into eventual application in rural health services in India.

With these limitations, developing a tight experimental design presented problems. Most fundamental was insistence on a high level of quality control in data collection. Even if we could not control all variables we should at least know what was going on in our villages. Therefore, the largest proportion of project costs went into well organized data collection. Prior methodological experience in the Khanna and Guatemala studies were very helpful especially in selecting variables to be measured[35, 36].

Similarly, intervention packages had to be evolved. In the usual

experiment a basic dogma is that the intervention being tested must be kept uniform throughout the study. We could not do that because our best judgement at the beginning of the study about what would be the best intervention package was within a few months often shown to be wrong. There was no point in holding rigidly to a pattern of work when straightforward field experience showed that there was a better way of doing the same thing. From the beginning, therefore, we defined broadly the interventions that were to be tried in each package of services, but within that grouping we deliberately set out to evolve improvements in service routines. This progressive refinement of services throughout the experimental period represented a parallel research effort in which systematic rapid feedback of results led to a deliberate effort to keep all field workers and scientists intimately involved in the search for innovations and practical improvements. As new measures were evolved we tried to implement them rapidly. The excitement of the field work was largely due to this dynamic process. However, the continuous evolution of services made the eventual analytical task much more complex.

In the analysis, we then had to sort out the interrelationships between the complex interacting variables relating to nutritional status, morbidity and mortality. We hypothesized that, in addition to their direct effects, poor nutrition would adversely affect morbidity, that high morbidity would decrease nutritional level and that poor nutrition and high morbidity together would act synergistically in raising child mortality. In addition, we were able to include measures which could presumably serve as indicators of maternal influences (birth weight, maternal height) and socioeconomic status (i.e., caste affiliations, land-holdings, parental occupation,

income, education). The outcome indicators were child nutritional status and growth, morbidity experience, psychomotor development and mortality. It was postulated that socioeconomic status affects child growth, child development, and morbidity mainly through three intermediate variables: availability and quality of mother care, quality and quantity of diet, and housing and environmental conditions.

Summary of Narangwal Results

In Chapters 2-7 detailed data are presented documenting the conclusions summarized in this section. The ways that these major findings can be applied in practical programs are outlined in Chapter 8.

1. Growth and Development

Nutrition care alone (NUT) or in combination with health care (NUTHC) significantly improved both weight and height of study children beyond 17 months of age. At 36 months, children from nutrition care villages weighed on the average 560 grams more, and were 1.3 centimeters taller than children in control villages. Children in health care villages (HC) had mean weights and heights intermediate between those in nutrition care and control villages. Among the many socioeconomic and demographic variables tested, sex and caste were shown to have an especially pronounced independent and additive effect which averaged .6 to .75 kilograms in weight and about 2 centimeters in height. A male, high caste child from a nutrition care village, therefore, averaged about 2 kilograms more in weight and 6 centimeters more in height at 36 months of age than a female, low caste child from a control village. Beyond 13 months of age the proportion of underweight children* in nutrition

* Arbitrarily defined as being below 70 percent of the Harvard weight median

care villages was consistently lower than in other villages. The difference between the proportion of underweight children in nutrition care and control villages was expectedly not impressive for high caste boys. On the other hand, this difference was highly significant for low caste children, and especially for females, suggesting that children whose undernutrition had resulted primarily from minimal care and poverty profited most from the program. Breastfeeding was prolonged by about five months as a result of special educational efforts in nutrition care villages.

As far as we have been able to determine, this project is the first to show in a controlled experiment significant differences in average growth of all children in communities receiving specified nutritional and health inputs. Although much epidemiological and program evaluation data supports the assumptions on which most health and nutritional programs proceed, the fact is that most controlled experiments in total village populations have been disappointing. Control groups have tended to improve along with experimental groups perhaps because as control children were being weighed and measured mothers spontaneously provided the extra nutrition care needed. In Narangwal we were able to demonstrate statistically significant differences between control and experimental groups by careful quality control and systematic program inputs.

Results from regression analyses on a subsample of 180 children on whom exact dietary measurements were obtained showed a strong relationship between dietary intake and achieved anthropometric status. Conversely, the amount of food consumed was associated with achieved growth and socioeconomic status. Psychomotor development was found to be directly affected by past nutritional status, and to a lesser extent by present nutritional status

and by past morbidity.

2. *Morbidity*

Health care (HC or NUTHC villages) caused a significant reduction in the average duration of infectious disease episodes as compared with villages without health care (NUT or CONT-N villages). Each episode of diarrheal disease was reduced on the average by 2 days, lower respiratory tract infections by 1-1/2 days, fever by 1 day, cough by 2-1/2 days, and skin infections by 1-1/2 days, in comparison with villages without health care. The only condition for which the combination of nutrition and health care exerted a larger effect than health care alone was eye infections. There the mean duration in NUTHC villages was 6.3 days, compared to 7.1 in HC, 8 days in NUT and 8.3 days in CONT-N villages.

3. *Mortality*

Perinatal mortality was significantly reduced in nutrition care villages (NUT and NUTHC), 31 per 1000 live and stillbirths; as compared to health care (HC), 45 per 1000 live and stillbirths; or control villages (CONT-N), 57 per 1000 live and stillbirths. This decline in mortality probably resulted mostly from improved nutrition of all mothers by supplementation with iron and folic acid, but we are not able to distinguish this effect clearly from the added influence that came from providing food from the feeding center during pregnancy to mothers judged by the family health workers to be nutritionally at risk.

Neonatal, postneonatal, and 1-2 year mortality were significantly reduced by one-third to one-half in villages where infectious disease control

services (HC or NUTHC) were provided as compared with control villages. Nutrition care (NUT) produced an intermediate effect under one year of age and an equivalent effect on mortality among 1-2 year old children. In four villages of the population project (FPWSCC) which also received comprehensive child care, active surveillance for illness in the course of home visiting was only one-eighth as frequent and early treatment for illnesses presumably was therefore less intensive than in infectious disease control villages (HC or NUTHC). From these less intensive activities, no effect on child mortality below 1 year of age was detected, but beyond 1 year of age mortality improvement was similar to that in health care or nutrition villages.

A concentrated effort focussing on analysis of program effects with rapid feedback to change service delivery sharply reduced mortality rates from the two main causes of death. In 1971, 44 percent of child deaths between 8 days and 3 years of age were caused by diarrhea and dehydration and 22 percent by lower respiratory tract infection, mainly pneumonia. A complete revision of standing orders and retraining in the recognition, management and follow-up of the two conditions resulted in delegation of increased responsibility for treatment (oral rehydration and penicillin injection) to the Family Health Worker (FHW). Mortality from the two conditions dropped by 50 percent over the succeeding 17 months. Mortality rates from other causes remained unchanged during this interval.

4. *Service Inputs, Costs and Cost/Effectiveness*

Detailed measurement of service inputs demonstrated clear differences between experimental groups in terms of staff time, service contacts and costs. The largest amount of service time and service contacts provided

per child were in NUTHC villages. However, the costs per unit of service were very similar in all experimental groups. The NUT villages were the most costly per child primarily because of the higher average number of child feedings provided per child under three. Costs in the NUTHC villages for combined nutrition and health care were about $21 per year per child under three, or less than $2 per capita of the total population. The average cost per service contact of $0.20 was about equal to the cost per patient visit in government primary health centers in Punjab in 1969. Costs per child feeding per session averaged about $0.04. (There were two feeding sessions per day, making the cost per day $0.08.) Because project services partially replaced use of private and government services, the combined child care and nutrition program (NUTHC) increased overall health care expenditures in those villages receiving the program by only 40 percent above expenditures in control villages for private and government care.

Cost/effectiveness calculations revealed that "prenatal child care" costs per perinatal death averted were the lowest in NUT villages ($7.75). The most favorable ratio of costs per infant death averted ($25) was found in the HC villages. The HC villages also produced the lowest costs per child death averted ($31 in children 1-3 years of age). Costs per day of illness averted in children under one year of age were $0.40 in HC villages and $0.56 in NUTHC villages. Similar calculations for children 1-3 years of age were $0.35 and $0.39 respectively. Nutrition costs per additional centimeter of growth attained by 3 years of age was $26 in NUTHC and $30 in NUT villages.

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CHAPTER 2

RESEARCH OBJECTIVES, DESIGN AND METHODOLOGY

Cecile De Sweemer, Arnfried A. Kielmann, Robert L. Parker and Carl E. Taylor

Field research can never be entirely quantitative. Measurements of complex phenomena within a population group must rely also on qualitative information. The cultural social and economic milieu of the study villages, the rationale behind the research design, the selection of specific service interventions and the motivations and objectives of the research team all were important in decisions about the research, and interpretation of the results.

Objectives

The research plans grew out of earlier experience in the Khanna[1] and Guatemalan[2] studies. The underlying goal was to contribute directly to rural health programs in developing countries. The research included both basic and applied research objectives. The basic research objective was to study the dynamics of interactions between undernutrition and infectious disease. The more applied objective was to determine the relative impact on the health of rural children of alternative interventions which were feasible and fundable within the constraints of health services in India and other developing countries.

1. *Basic Research Objectives*

a. To measure the extent to which health care, mainly focussed on infectious disease control, influenced morbidity prevalence, mortality and nutrition status.

b. To determine the effects of nutrition care, consisting of nutrition education and selective supplementation, on child growth and development, mortality and infectious disease experience.

c. To determine the effects of combined nutrition care and health care on the same indicators of child health.

d. To determine the influence of selected socioeconomic and demographic factors on each of these interactions.

2. *Applied Research Objectives*

To evolve practical field procedures for implementing service programs that are effective and feasible, within the cost and administrative constraints of rural health services for:

a. selected nutrition care measures;

b. selected infection control and health care measures;

c. the optimal functional combination of both nutrition care and health care measures; and

d. the population characteristics, such as age of child, which determine when each component of the integrated care package can be most effectively and efficiently introduced.

The achievement of these multiple objectives in one project was complex. There was need to maintain data quality within a fixed research design providing measurable inputs (services provided), outputs (services used) and

outcomes (impact attributable to services) so as to analyze the relative cost and effectiveness of specific interventions. At the same time, we concentrated on using low cost methods in providing health and nutrition care to ensure that results reflected what could be implemented eventually in a national program. Furthermore, since this kind of action research had only rarely been attempted, there were numerous methodological problems that had to be worked out in an evolutionary way with experience gained at early stages of the project being used to modify field procedures. Extremely delicate ethical issues had to be resolved in maintaining the controlled experimental design.

Research Design

The research design of the Nutrition Project as seen in Chapter 1, Figure 1.1, includes the following experimental groups: nutrition care (NUT); health care (HC); nutrition and health care (NUTHC); and a control group (CONT-N) for the nutrition project. In addition, we also included some data from a parallel population project at Narangwal, in particular from an experimental group receiving nutrition and health care for children plus women's services (NUTHC-P), and from the population control group (CONT-P). The nutrition care villages were provided nutrition surveillance, education and selective supplementation. Health care villages received infectious disease surveillance, early treatment, immunizations, and education for preventive measures. Integrated care villages received a combination of both types of services; no effort was made to provide exact replication of both sets of inputs but instead a major objective was to evolve functional integration of

both types of services. Because we were concerned especially about the applicability of our results in general service program, each program package was designed for independent implementation. In each group of villages the service packages differed qualitatively in the internal balance of how the various components were put together. An effort to equalize overall quantitative inputs in each village was made in the general service load assignments of lady health visitors who were trained by the project and designated family health workers (FHW's). Precise measurements of time spent in specific activities were made so as to provide comparative analyses of actual work distribution.

In all four groups of villages in the nutrition project the measured outcome variables were physical growth, morbidity, and mortality of children from birth to 36 months. The study universe consisted of an average mid-year population of approximately 1,000 children below three years of age who were permanently living in the ten selected villages or who had resided there for at least six months. After the design stabilized, three villages (Mansuran, Rattan, and Saya) with an average total 0-3 year old child population of about 450 constituted the combined care group (NUTHC). Three villages (Kaind, Bool, and Gurm) with a total of about 230 children formed the nutrition care group (NUT). Two villages (Rattowal and Tugal) with a child population of about 230 constituted the health care group (HC). Two villages (Jand and Ghuman) with a child population of about 190 were the control villages (CONT-N). In the last year Ghuman was dropped from the study because an increasing number of its residents found employment at a nearby airfield leading to a dramatic improvement in their socioeconomic status and access to medical facilities. (See Chapter 1, Figure 1.2 for physical map locations)

In order to have a larger population base for control vital rates, we included both birth and death rate statistics from four control villages (Leel, Rajgarh, Dangon, and Nangal) from the parallel Narangwal study on population dynamics which was conducted in other clusters of villages (CONT-P). Children in control villages of the nutrition project received minimal symptomatic and emergency care while in the control villages of the population project they received no curative or health promoting services from project personnel. We were also able to measure the effects of less frequent and intensive health and nutrition surveillance on mortality and growth by including relevant information from four child service villages (Ballowal, Chaminda, Dhaipee and Dolon) of the parallel population project (NUTHC-P).

Children from the ten nutrition study villages also formed a population pool from which samples of children were drawn for a number of ancillary studies that were carried out during the project.

Experimental Group Characteristics

A conscious effort was made to select villages that would provide relative comparability between experimental groups in major socioeconomic characteristics. Other selection criteria included year-round accessibility to jeep travel. A great deal of negotiation with village leaders was required to get consent and cooperation in becoming part of the experiment. A special criterion for control villages was that they should have good access to a government primary health center and other sources of health care, and not be left completely without care. In spite of these efforts to ensure

similarity among experimental groups the inherent variation among villages produced important differences between experimental groups. Table 2.1 summarizes a number of characteristics for all the experimental groups included in the subsequent analyses. Many of the analyses attempted to adjust for these differences by controlling for variations in caste distributions and other socioeconomic variables. Caste was strongly associated with health outcome measures, as well as being highly correlated with other socioeconomic characteristics.

In summary, Table 2.1 shows that the control villages of the nutrition project had higher socioeconomic status. Conversely, by many indices the combined NUTHC villages were the most deprived of the study villages. Thus, project interventions had to overcome significant initial differentials in key descriptive indicators. This would suggest that the findings of positive impact are even more significant than if the descriptive information had shown the villages to be more nearly similar.

Important differences in the nutrition control villages included a lower male to female sex ratio (103 compared with close to 120 in other villages) due, no doubt, to the fact that more of the men from the control villages worked in the cities or were in the armed forces. These villages have the highest median non-farm income and highest percent of non-farmer, non-labor occupations. The literacy rate (46 percent) type of housing and availability of water were all best in CONT-N villages. Electrification was, however, low in these villages because one control village had not been reached by the rural electrification program at the time of the socioeconomic survey.

Conversely, important differences indicating lower socioeconomic status

Table 2.1

SELECTED DEMOGRAPHIC, SOCIOECONOMIC, AND OTHER CHARACTERISTICS OF THE EXPERIMENTAL GROUPS OF VILLAGWS - 1971

	NUTRITION PROJECT				POPULATION PROJECT	
	NUTHC	NUT	HC	CONT-N	NUTHC-P	CONT-P
No. of Villages	3	3	2	2	4	4
Census Population*	4623	2646	2613	2120	5877	5047
Percent Under 3	9.1	8.2	8.3	8.3	9.1	8.4
Percent Married Women 15-49 Years	17.5	16.4	16.0	18.5	17.9	18.0
Sex Ratio (M/F x 100)	117	118	121	103	117	108
Caste Groups:						
% Jat	40.8	56.3	55.0	50.1	50.3	53.9
% Ramdasia	39.2	25.9	29.6	30.2	33.1	34.9
% Others	20.0	17.8	15.4	19.7	16.6	11.2
Percent Literate	34.0	31.5	40.8	45.5	33.1	34.3
Occupation of Head of Household						
% Farmer	33.6	48.8	42.5	47.4	41.7	43.0
% Laborer	35.7	22.8	34.1	17.3	34.5	29.8
% Other	30.7	28.4	23.4	35.3	23.8	27.2
Housing						
% All Mud	21.0	20.9	33.2	14.3	31.2	33.9
% Courtyard Hand Pump	93.3	90.0	85.9	95.2	88.9	85.0
% Lane Drains	55.4	39.9	69.7	53.9	44.2	38.8
% Electrified	42.8	46.1	32.1	24.3	42.2	28.6
Farming						
Median Land Acreage**	5.0	6.4	4.8	4.9	5.7	7.8
% Tractor Users	17.7	26.5	18.3	19.9	8.2	22.8
% Tubewell Owners	21.3	36.9	28.2	30.8	27.2	33.3
Household Annual Income and Possessions (US$)						
Median Total Income	323	344	276	306	292	289
Median Non-Land Inc.	162	178	145	187	77	75
Median Value of Poss.	508	679	586	560	521	572
Accessibility*** (Km)						
To Project Center	6	10	16	12	4	NA
To Closest Other Facility	6	10	4	3	4	2
To Market Town	10	13	11	9	13	9
To City (Ludhiana)	19	16	28	28	23	33

* Individuals (primarily women and children) identified through provision of services and by means of other surveys, but not innumerated on the census would increase the total population by about 5 percent in each experimental group.

** Median of households owning land.

*** Mean distance in kilometers weighted by village population.

were found in the other villages. The NUTHC combined care villages had the smallest percentages of Jat (high caste farmers) and the largest percentages of low caste groups. These villages along with NUTHC-P villages also had the highest proportion of population who were children under three, primarily because lower caste families have higher ratios of children to adults. There was a smaller proportion of farmers (land owners) in the NUTHC group, also related to the caste distribution. Both NUTHC and NUTHC-P had the least agricultural mechanization as indicated by use of tractors and ownership of tubewells.

In summary, these differences and others shown in Table 2.1 should be kept in mind when interpreting the results of experimental group comparisions. If we had been able to select villages with identical characteristics it is possible that even greater differences in health and nutrition service impacts would have been demonstrated between study villages and controls. Similarly, the combined health and nutrition villages may have shown even greater effects when compared with villages receiving only health care or nutrition services.

Methods Used for Data Collection

Formal data collection within the experimental design started only after a prolonged tooling-up period in which physicians and public health nurses developed and refined test instruments. It was also necessary to develop methods of training the first family health workers (FHW's) who not only provided services but also gathered research data in longitudinal and cross-sectional surveys.

1. *Longitudinal Surveys*

Each FHW was responsible for collecting data on: morbidity, anthropometry, diets, vital statistics (births and deaths), and fertility. The

morbidity survey was conducted weekly for each child up to three years of age in every village (including the control villages) of the nutrition project. Based on the mother's recall, a detailed record was obtained of both the incidence and the duration during the preceding six days as well as the day of interview. Local terms were used in a standardized format to define illnesses according to a list of 44 clinical signs and symptoms. This history was supplemented by a physical examination which obviously had to be limited to the day of the visit. For children who had been outside the village for more than 14 days, recall data were collected for the preceding two weeks.

Anthropometric measurements (weight, height, and from 1971 on head circumference) were recorded in the ten villages of the basic nutrition project and in the four child service villages of the population study (NUTHC-P). These measurements were made at intervals conforming to the decelerating rate of growth of children over the first three years of life so that in each time period there would be an expected average weight increment of 250 grams. Measurements were scheduled once every month for the first nine months, once every two months between 9 and 21 months, and once every three months between 21 and 36 months of life. Measurements were taken on the day of the month corresponding to the birthday, plus or minus five days.

Initially, the FHW's in nutrition care villages gathered simplified recall data for a dietary survey which was developed to monitor feeding and weaning patterns and provide feedback for individual and group nutrition education. Later the survey was expanded to all villages to measure and compare specific program effects relating to breast feeding and weaning feeding patterns. This dietary survey was taken once every three months.

On a subsample of 170 children a detailed dietary survey was carried

out to determine both qualitative and quantitative nutrient intakes in our study population. The methodology employed was actual observation and weighing of all food items consumed over a period of three consecutive days[3]. Mean caloric intake above 12 months of age was 1120, 86 percent of the NRC recommendations and mean protein intake was 22 grams, 96 percent of NRC recommendations. Longitudinal surveys showed that more than 50 percent of these children were malnourished according to the Gomez classification (less than 85 percent of the Harvard standard 50th percentile of weight for age). The fact that there was so much malnutrition even though average food consumption was close to recommended allowances was presumable due to increased nutritional demand because of the infection and malabsorption and, perhaps, to inequitable distribution of food in the community.

Vital statistics information was collected in three ways: the FHW in the course of her regular activities; special vital statistics investigators who collected information from a group of 8-10 selected informants in each village once every two weeks; and the village watchman (chowkidar) who is the government's source of vital statistics information from rural areas. Vital events were recorded as they occurred with separate forms for births and deaths being turned in monthly to the Narangwal data pool.

A fertility survey every two months served to identify pregnancies early in order to start prenatal care, to prepare for the impending arrival of a new born to be included in the study and to establish menstrual patterns in a normal population of village women. This information also helped in the very difficult task of getting precise numbers of births and stillbirths and detecting early child mortality. Most of our problems in getting valid vital statistics arose because local cultural practices dictated that

mothers go to their parental homes in another village for the first two or three births. This meant that for about one-third of the births mothers were absent from the village for several months before and after delivery. The fertility form was designed to monitor pregnancy status and menstrual patterns of all married women between 15 and 49 years. In addition, it recorded the expected date of delivery, dates of prenatal administration of tetanus toxoid in HC and NUTHC villages, iron and folic acid supplements in NUT and NUTHC villages, information on the date of delivery, outcome of pregnancy, birth weight, and nature and dates of postnatal care.

For every child attending village subcenter clinics which were held five afternoons a week, a clinic record was maintained on which the FHW, the public health nurse or the physician recorded the history, management, outcome, and follow-up of specific illness episodes. These records were subjected to a detailed service records analysis.

Essentially, the same personnel simultaneously assured the quality control of research data and supervised service delivery at the subcenter. The supervisory staff of physicians and public health nurses carried out routine checking of service records and scrutinized research records for completeness of recording, internal consistency, and comparability with other records. In addition, a specially trained FHW repeated a spot-checking assessment of a randomly picked subsample from the morbidity history and physical examination data one day after the FHW visited homes, making her rounds about once every 10 to 21 days in every village. An additional quality control mechanism at the Narangwal Research Center consisted of a monthly scrutiny of the number and completeness of morbidity, feeding center and vital statistics records. These were compared with monthly food and drug requisitions submitted by the FHW.

2. *Cross-Sectional Surveys*

Cross-sectional surveys were conducted at approximately two year intervals. Special teams of Punjabi investigators, most with a Master's degree in social sciences, covered all study villages. They collected data on all households to establish population baselines and intermediate results. Principal surveys included census, recensus, socioeconomic status, pregnancy history, beliefs about child survival, anthropometry, dietary intake, and biochemical indices. The census records and pregnancy histories also contributed information on births and deaths.

Content and Methodology of Services Delivered

The services were flexibly adapted and improved as research information was analyzed and deficiencies were identified. The goals were to develop health care delivery service packages sensitive to the needs of a rural Indian preschool population and realistic with respect to the manpower and budgetary constraints prevailing in the country. At the same time, we were constantly testing new approaches which might have the potential of increasing the maximum experimental effect.

The experimental design imposed the need to develop packages of field-tested and carefully selected activities that fell within the competence of auxiliary workers and could be adapted to national programs. Keeping in mind the present distribution of health manpower and facilities in India and most of the lesser developed countries of the world, we developed services according to the following basic principles: maximum delegation of responsibility to auxiliaries with the minimum training consistent with good care: primary health care provided as far as possible at the periphery; delegated respon-

sibilities supported by good communication and medical back-up from the center; emphasis on preventive measures applied to the total population; early diagnosis and treatment to prevent disease progression in individuals; home contacts in approximately equal balance with clinic contacts; and a pervasive system of supportive supervision providing interactions among all members of the health team.

Rather than waiting for parents to seek crisis care, both nutrition and health care approaches relied on surveillance techniques to identify problems early. Most service activities were based on early diagnosis and prompt intervention and on standard preventive measures.

Since FHW's had to provide health services as well as maintain research activities, each was assigned responsibility for 75-95 children below three years of age in the combined care villages and 90-120 children in other villages.

1. *Nutrition Care Villages*

Nutrition services consisted of surveillance, selective food supplementation and nutrition education. The intensive surveillance system based on regular measurement of weight and height has already been described under data collection. Participation of malnourished children in the food supplementation program, though voluntary, was encouraged mainly through social pressure. When the feeding program began, supplementation was limited to severely malnourished children below 60 percent of the Harvard median weight for age standard. Within a few months, as conditions improved, we included all malnourished children below 70 percent of the Harvard standard. In the last two and a half years of the project any child in the village was

encouraged to attend, but special attention was still focused on those showing a weight deficit. Twice daily, family health workers or feeding center attendants prepared and distributed food supplements consisting of calorie-fortified milk in the morning and porridge made from crushed wheat, milk powder, raw sugar, and oil in the afternoon. Standard servings of the daily supplement, if taken on both occasions, provided approximately 400 calories and 11 grams of protein. Although children were allowed to eat as much as they wanted, few were able to consume more than one serving at a feeding session.

When children dropped below 70 percent of the Harvard median weight for age standard, a special effort was made to encourage their regular attendance at the feeding station. This was sometimes difficult to achieve because most of the malnourished children came from the lower socioeconomic class and their families found it difficult to bring them. Specifically, their parents and older siblings often had to work all day in the fields of landowners and did not have time to bring small children to the center. This occurred most often during the harvest when infants and toddlers were left in the care of siblings only slightly older then themselves, or at best, with an old and usually ill relative. Under these circumstances nutrition center attendants delivered food directly to homes and supervised the feeding.

Nutrition education programs concentrated on encouraging late weaning (beyond 18 months) and consistent supplementation starting at 4-6 months of age. During the diet history every three months the FHW reinforced the need for breast feeding and good feeding habits. They tried to correct practices found to be faulty and used research information for focussed educational support. Nutrition education classes for groups of mothers

and dais (traditional village midwives) were occasionally held. These meetings were organized mainly for mothers of malnourished children.

2. *Health Care Villages*

For children up to three the service package developed for health care included curative and preventive care for common illnesses, especially infections, immunizations and education to improve general hygiene. The main emphasis was on surveillance for early diagnosis and treatment. Cases were identified either through home visits or in village clinics. Home visits were made in the mornings and clinics in the village subcenter were held in the afternoon five days a week. Emergencies were seen in the home or clinic at any time. For children through fourteen years of age curative services were available on demand.

During the weekly morbidity survey, children with any kind of illness or injury were treated in the home, or referred to afternoon clinics if necessary for more intensive work-up. Children who became ill between home visits were brought by a parent or sibling to the afternoon clinic. A physician visited once a week in all villages which received health care and every three weeks in the nutrition only and control villages to see only those patients who had been screened and referred by the FHW. The physician also made follow-up visits to patients previously seen by him, and met with village leaders to discuss new programs or community problems. For emergencies, FHW's could summon a physician from the Narangwal Center at any time, usually sending a note with a family member on a bicycle.

In all villages of the project, smallpox vaccination continued to be provided by the government health services. In addition, the FHW routinely

gave primary vaccinations to all children missed by the government vaccinator and eventually to infants born between vaccination rounds in HC or NUTHC villages. She also gave DPT immunizations to preschool children and tetanus immunizations to prenatal mothers. BCG and measles immunization were provided on a campaign basis because of the necessity for refrigeration of both vaccines and because the relatively small number of children to be vaccinated in a village made the use of standard BCG ampoules containing 50 doses uneconomical. In NUT and CONT-N villages only a small minority of the children were reached by government programs for vaccinations other than smallpox, except that in the last year of the project two NUT villages were included in a governmental BCG program.

3. *Combined Care Villages*

The combined care villages received both the nutrition and health care inputs. These services were, however, carefully integrated. Home visits were scheduled to take care of multiple activities simultaneously and clinic visits were scheduled to promote efficient coverage and reduce waiting time for family members. A deliberate effort was made to link activities so as to mutually reinforce acceptance and learning of simple preventive measures.

4. *Control Villages*

In the control villages no services other than symptomatic care on demand was provided. Symptomatic care was limited to aspirin, gentian violet, and boroglycerin.

The prospect of collecting data on sick children who might die if no care was provided raised serious ethical issues which led to a compromise arrangement. In the nutrition only, health care only or control groups of villages, if in the opinion of two physicians (one if it was an acute medical emergency) a child would either die or suffer permanent loss of sight if therapy were not instituted, then full treatment (either medical, nutritonal, or both) was provided on an emergency basis. Such a child was then statistically tagged as a "technical knock-out" (TKO) and, from then on was eligible for full treatment. At the time of analysis these cases were not included as "fatalities" in the numerator.

Personnel

1. *The Physician*

The physicians shared responsibility for the overall running of the project. They served as medical consultants to whom both the family health worker (FHW) and public health nurse (PHN) referred those children who required specialized or emergency care as indicated in standing orders. The physicians were actively involved in the writing of standing orders and manuals, and assisted the PHN's in the preparation and implementation of training programs. A special responsibility of the physician was to determine as accurately as possible the cause of each child death in study villages. As soon as possible after the death the physician questioned family members, the FHW, and relevant private practitioners and hospital personnel about the terminal illness. All available records such as growth charts, morbidity and clinic records were reviewed and a provisional cause of death was established. Subsequently, the physician presented his findings from this "verbal autopsy" at a staff

conference and a "most likely" cause of death was agreed upon.

2. *The Nutritionist*

Although her qualifications and experience were in biochemistry and research on growth and development, the nutritionist was mainly responsible for central administration and supervision of the food supplementation program. She also planned and implemented more specialized nutrition research activities and laboratory work for several ancillary studies.

3. *The Public Health Nurse (PHN)*

The FHW's direct supervisors were the public health nurses (PHN's). The PHN played a major role in the proper functioning of both day-to-day services and research activities. In a dual role, she was responsible both for supervising FHW's, serving as consultant, teacher and a member of the primary health care team, and was also responsible for quality control of the data collected by FHW's. She formed the main link in integrating research activities at Narangwal with the village subcenters. She was actively involved in the designing, pretesting, and revising of both service and research records and had primary responsibility for planning the ongoing auxiliary training program. A very important function was the elaboration and coordination of village work schedules, and the preparation and revision of the content and methodology of standing orders and work manuals.

4. *The Family Health Worker (FHW)*

Throughout the project the theme was publicly pronounced and frequently reiterated that the FHW's were the most important members of the

health team. The family health workers in the nutrition project all had previous training as lady health visitors. In government services, lady health visitors are primarily used to supervise auxiliary nurse midwives (ANM's) who work in subcenters of both urban and rural primary health centers. Their curriculum provided experience in home visiting as well as the preventive and curative aspects of child and maternal care as they have been developed in the service programs of a governmental primary health center. Their basic education is two and a half years following high school.

Family health workers were selected by the usual practice in India of advertising in local newspapers that a specified number of positions were available for graduates of schools for Lady Health Visitors. Preliminary screening of applicants included academic performance and references. Candidates invited for interview were given a variety of tests for practical performance and a "non-verbal logic test" (Ravens Matrix test). They had to be able (or willing to learn) to ride a bicycle and live by themselves in a village. We especially tried to assess their attitude toward village people as a measure of adaptability to village life.

Following their selection, FHW's went through an intensive orientation and training period to acquaint them with the specific service and research requirements of the project. At the outset, the FHW's underwent 18 weeks of training at the Narangwal Center. As the project progressed, the pre-service training period was shortened to six weeks in all, without apparent loss in learning ways of working with village people as well as technical skills. A particularly effective pattern was established of one week in Narangwal followed by two weeks mostly spent in the field living with an experienced FHW and her supervisor, followed by three weeks alternatingly

spent in the field and at the Narangwal Center. From the beginning it was recognized that the most important training would be on-the-job under the guidance of the PHN and physician.

During the first week of the preservice training the main emphasis was on telling the FHW what her work was going to be and helping her to become familiar with the aims and objectives of the research. Her specific duties were systematically explained both in relation to the kind of services she would provide and the survey data she would collect. In learning home visiting techniques she was trained in approaching and establishing rapport with village women, asking questions appropriately, and listening to and recording women's responses.

Starting in the second and extending through the third week, the new FHW repeatedly spent several days at a time with an experienced FHW at one of the established village subcenters to observe day-to-day functioning of routine service delivery and data collection activities, to become familiar with specific child care and family care services as well as with the necessary administrative work. This alternated with periods back at the Narangwal Center at which she had a chance to get her questions answered and get theoretical training. More importantly, this period gave the FHW an intensive exposure to what had been learned in the project of personal ways of adapting to village life. The fourth and sixth weeks were again spent living with an experienced FHW in a village subcenter to get practical experience. The fifth week was spent in Narangwal to firm up basic knowledge and skills relating to child care, nutrition and family planning. This alternating process of exposure to practical experience and theoretical training pro-

vided the trainee with opportunities to get practical questions answered as they came up and learning was greatly accelerated. Following completion of the six weeks preservice training, new recruits were sent to work first at one of the larger villages where two FHW's were normally stationed so that she could get support as needed.

Two of the more experienced FHW's were assigned as "relievers" with temporary responsibility for a village during absences of the worker normally responsible for that village. Experience was essential for such a position since the FHW had to perform in any of the four input cells and had to be familiar not only with each of the specific work routines but also with the geographic arrangements of all villages.

Initially every week and later every 14 days, FHW's from all villages came to the Narangwal Center for a full day of formal training sessions. These trips also served administrative purposes ranging from getting their pay to picking up their quota of medications and food supplies. During these training sessions, their basic knowledge and techniques were reviewed and upgraded and specific case presentations were dissected in detail by the peer group. Especially useful were attempts to find solutions to common problems encountered in daily routines.

This pattern of continuing education was an extremely efficient way of augmenting knowledge and skills in direct relation to specific problems emerging from daily work. The biweekly training days also proved to be an extremely important means for maintaining morale. It was the best time for the professional staff to learn from the day to day experiences of FHW's as they shared their insights and understanding of village problems.

During discussions, one would frequently hear, "I had that problem and this is how I solved it." Or, a lengthy discussion on how the problem might be solved would lead to various FHW's trying out various ideas with feedback in an evolutionary problem solving approach.

Special topics for training discussions included preparations for non-routine programs such as immunization campaigns, organization of day care centres during harvest, methods for special cross-sectional surveys, and recognition and management of high risk diseases. For instance, prior to the onset of the diarrheal season the signs and symptoms of dehydration, various methods of rehydration emphasizing especially the oral route, and the importance of close supervision and prompt referral of critically ill children was reviewed. Similarly, before the cold season, special attention was given to reviewing signs for recognition of lower respiratory tract infections and the treatment and assessment of the progress of pneumonia. Teaching methods included informal lectures, discussions, group workshops, case presentations and role playing.

During the second part of the project, in addition to the training days at the Narangwal Center, every other week a 3-4 hour conference was held in one of the villages of each study group. These reviews of progress involved the physician, the PHN, FHW's from other villages of that group and, in nutrition supplementation villages, the nutritionist. Village visits rotated so that each was covered every four to six weeks. During this conference, a random sample of service and research records was examined and criticized. The FHW's also brought up special problems and solicited help, especially from other FHW's. Throughout the project salaries of FHW's were kept at par with those for similar workers employed by the Indian Council of Medical Research. Especially during later years, this level was below that paid by the State of Punjab to the Lady Health Visitors.

5. *Feeding Center Attendants*

Our main use of community health workers was in nutrition villages, where local women were trained to serve as feeding center attendants. Selection was carried out with the participation of panchayat leaders. Care was taken to determine that those selected were acceptable to all segments of the village. The most important requirement was that the attendant be willing to work intensively with low caste people. They became extremely capable in handling the multiple responsibilities associated with preparing and distributing food and providing follow-up for children identified as being in special need.

A second program was to work with and train village dais (indigenous midwives) but our coverage never became sufficiently great to have a systematic impact.

Standard Operating Procedures

The basic daily work routine was similar in all villages and consisted of home-visiting during early morning hours, a one-to-two hour lunch break around noon, work in the subcenter until late afternoon, and then more homevisiting in the early evening. During the morning home visits, most of the ongoing longitudinal survey data were collected. Evening home-visits were for follow-up visits, home treatment, immunizations and the completion of unfinished surveys. At the subcenter, daily clinics were held, routine anthropometric measurements were taken and day-to-day administrative chores performed. The FHW understandably spent considerably less time in the clinic in control villages. In villages receiving nutrition services, the FHW

was responsible for the supervision of feeding center attendants and the proper functioning of the feeding center.

Once a week a PHN visited each FHW and spent at least half a day in each village to check and discuss all aspects of the work. These visits served both as informal training sessions and as problem solving opportunities. Supervision was supportive rather than punitive.

The many sociological and cultural problems in each village included complaints arising from competition between village factions, cultural resistance to services offered for the first time, dissatisfaction of family members with the behavior of the FHW and vice versa, and rumors and misunderstandings in our relations with traditional practitioners. Such problems were first handled by the FHW; if she was unsuccessful, she would ask the PHN for help, if she also met with little success the physician tried to work out a solution, and finally a project social scientist was called in.

Village Participation and Interactions

A sincere effort was made not to interfere with established village routines, beliefs and practices. Where local traditions were contrary to our program purposes and efforts, we patiently tried to convince individuals or communities and get their cooperation. In our relations with indigenous practitioners and dais we tried to classify their practices according to whether the effects were favorable, neutral or dangerous. We then concentrated our educational efforts on trying to modify what was dangerous and support the rest of their work. Some treatments prescribed by indigenous practitioners produced effects opposite to our treatment. For example,

in diarrheal disease it was traditional in families to withhold food and fluids thus precipitating dehydration and malnutrition. They also gave herbal powders, some of which were meant to increase stool frequency in order to get rid of the "poison."

Resistance to our services was mainly among some families who did not want to have babies weighed. Specifically, there was a strongly held general belief that marasmus (known locally as "sokha" which means drying-up) was caused either by "evil eye" or by "parchawan." Comments about a child being well-nourished were believed to produce envy among spirits and neighbors and the resulting evil eye would make the child wither. "Parchawan" is a shadow casting which results even from the casual falling of a shadow of any "impure" person on the child. Mothers with marasmic children, a marasmic child, and even menstruating women were among those who might cause "parachawan." Because these beliefs were firmly held we took great precaution not to make praising remarks and expose information about children in public. Care about such cultural considerations permitted good coverage of growth surveillance. In addition, the custom of having mothers go to their parental home for the birth of the first several children also made it difficult to get birth weights and weights up to one month of age.

Community Participation

A general objective was to promote direct participation of village communities in service activities and help them learn how to solve their own health problems. We were totally dependent on village cooperation and much time was spent in negotiations with panchayat members. Throughout the program

villagers assisted in the organization and execution of all major vaccination campaigns and community educational activities. They provided buildings for the village subcenters and feeding centers.

We observed early in the study that a disproportionately large number of children became malnourished and ill during or at the end of the main harvest in May and June. At this time most villagers, including especially lower caste women, were in the fields all day working extremely hard to bring in the harvest wheat. If their children were able to walk they were taken along, otherwise they were left in the care of a slightly older sibling, with an elderly or sick relative, or occasionally left in the home alone. In addition to receiving little care the baby had to adjust to temperatures often between 40^{o} and 47^{o} (110^{o} and 118^{o}F) for as long as 10 to 14 days at a stretch. Most children lost considerable weight. If they became ill with diarrheal disease or fever they rapidly became dehydrated and required emergency care. A demonstration day care center was organized and first run by FHW;s in one of the smaller villages. Because everyone agreed that this had worked well, the next year we suggested that the village provide food, furniture and recreational equipment and payment in the form of a special allocation of wheat from the harvest for two locally recruited mothers to look after the children, cook and generally assist the FHW. Satisfaction was so great that the program was later expanded to other villages.

Similarly, another almost accidental event led to a worthwhile general pattern. In mid-1971 we temporarily ran out of wheat in four of the feeding centers. Volunteers from the village panchayat went from house to house and collected enough wheat from landholding farmers to last until the end of the

year. This suggested that it would be a reasonable general principle to have the panchayat collect grain from the farmers at harvest time and store it for use as needed. Again in mid-1972 when we ran out of milk temporarily community leaders in two villages were sufficiently concerned to collect pledges for enough fresh milk to keep the program going until a new stock arrived.

Possibilities for Wider Program Application

The reason for this detailed presentation of the service patterns evolved at Narangwal is to help future implementation of primary health care in general governmental programs. Obviously specific activities need to be adapted to local conditions, even for the various parts of India.

The most complete exposition of the actual work routines is found in the two manuals that were published from Narangwal. The Child Care Manual[4] presents a detailed statement of each of the activities that were found to be useful. Similarly, the Nutrition Manual[5] gives a straightforward and simple description and justification for the nutrition components of the work. Both are widely available in India as training and reference manuals for auxiliaries and as home treatment reference books for middle class mothers. From this experience we are convinced that the only right way to write a manual is during a field project on the basis of practical measures evolved from day-to-day work in village homes and subcenters.

Finally, as we present the definitive research data in the chapters that follow we would like to stress that Narangwal-type services are eminently feasible and can be readily adapted to other situations. We

never expected administrators, even in the Punjab, to implement what was learned at Narangwal in totality. The final cost effectiveness calculations provide a sort of cafeteria choice of interventions each with an apprcximate price tag. The administrators can select from these and adapt a combination or program mix that is most appropriate to each local setting.

References - Chapter 2

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CHAPTER 3

CHILD GROWTH, NUTRITION AND PSYCHOMOTOR DEVELOPMENT

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Physical Growth

Growth was monitored through regular anthropometric measurement of all children in the study villages. From October 1969 until May 1973, 15,365 measurements were made at prescribed protocol ages (monthly up to 9 months, every two-months between 9-21 months, and every three months between 21-36 months).

Statistically significant associations between achieved weights and heights and a number of socioeconomic, demographic and research input variables were found by simple correlations. In order to determine more accurately the relative strength of relationships, multiple linear regression analyses relating weight or height to various sets of variables were performed for fourteen protocol ages: birth, 1,5,9,13,15,17,19,21,24, 27,30,33 and 36 months. The variables used for these regressions were sex, caste, experimental group, season and year of measurement, number and sex of living siblings and maternal age. Figures 3.1 and 3.2 show the significance and direction of relationships of socioeconomic, demographic and experimental variables with weight and height. Significance tests indicate the factors that have explanatory importance.

Figure 3.1

DIRECTION AND STATISTICAL SIGNIFICANCE OF SOCIOECONOMIC, DEMOGRAPHIC AND EXPERIMENTAL EFFECTS UPON WEIGHT AT AGES 0-36 MONTHS

FACTOR	DF[1]	0	1	5	9	13	15	17	19	21	24	27	30	33	36	Direction of significant effects
SEX	1		ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	M > F
CASTE	2		o	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	High > Middle > Low
NO. SIBLINGS	4				o	o	oo	o	s	oo	oo	o		o	o	E, C > A > B, D[2]
MATERNAL AGE	3	o			s	o	oo	oo	o	o	o	o				Old > Middle , Young
EXPERIMENTAL GROUP	3	s	o				o			o	o	o	o		o	Age 0-1: CONT-N > HC > NUTHC > NUT All other ages: NUT, NUTHC > HC > CONT-
SEASON	3			ooo	ooo	ooo	ooo	ooo	ooo	o	oo	ooo	ooo		o	Cold > Mild > Hot > Wet
YEAR	3	ooo	o										o	o	o	Ages 0-1: 68-69 > 72-73 > 70 > 71 Ages 27-33: 70 > 71 > 72-73 > 68-69
SAMPLE SIZES		540	559	803	795	725	758	762	752	733	714	669	651	603	542	
R^2		.09	.15	.34	.31	.34	.31	.28	.28	.26	.27	.23	.20	.20	.19	
SE (Kg.)		0.52	0.67	0.84	0.95	0.94	0.98	1.01	0.99	0.99	1.06	1.12	1.18	1.22	1.26	

1 Degrees of Freedom

2 A: 0-1 Male siblings, 0-1 Female siblings
B: 2+ Male siblings, 0-1 Female siblings
C: 0-1 Male siblings, 2+ Female siblings
D: 2+ Male siblings, 2+ Female siblings
E: Unknown

s: $p < .10$
o: $p < .05$
oo: $p < .01$
ooo: $p < .001$

Figure 3.2

DIRECTION AND STATISTICAL SIGNIFICANCE OF SOCIOECONOMIC, DEMOGRAPHIC AND EXPERIMENTAL EFFECTS UPON HEIGHT AT AGES 0-36 MONTHS*

FACTOR	DF[1]	0*	1	5	9	13	15	17	19	21	24	27	30	33	36	Direction of Significant Effects
SEX	1			ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	M > F
CASTE	2		oo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	High > Mid > Low
NO. SIBLINGS	4			o	o	o	ooo	ooo	o	s	o	ooo	ooo	oo		E, C > A > B, D[2]
MATERNAL AGE	3				o	s	o	o	oo	oo	oo	oo	o	o		Old > Middle > Young
EXPERIMENTAL GROUP	3		o					s		oo	ooo	oo	ooo	oo		Age < 17: HC > NUTHC > NUT > CONT- Age ≥ 21: NUTHC, NUT > HC > CONT-N
SEASON	3				oo		oo		oo	o	s	oo	s	oo		(Not consistent)
YEAR	3		o	s		s		o			o					68/69 > 70 > 72/73 > 71
SAMPLE SIZE			161	570	593	590	621	638	613	616	624	580	585	559	512	
R^2			.26	.25	.32	.27	.29	.27	.27	.26	.25	.20	.20	.22	.19	
SE (Cm)			2.52	2.66	2.58	2.78	2.84	2.99	3.03	3.21	3.41	3.50	3.68	3.76	4.01	

1 Degree of Freedom

2 A: 0-1 Male siblings, 0-1 Female siblings
B: 2+ Male siblings, 0-1 Female siblings
C: 0-1 Male siblings, 2+ Female siblings
D: 2+ Male siblings, 2+ Female siblings
E: Unknown

s: $p < .10$
o: $p < .05$
oo: $p < .01$
ooo: $p < .001$

* Results for age O are omitted due to small sample size.

The most consistently significant differences were found for sex, caste, and season. The number of siblings and maternal age showed a somewhat weaker but generally significant pattern. Sex and caste showed some interaction with intervention effects as described later. Brief descriptions of the influence of season, family composition and maternal age on growth are presented first.

Season had a distinct and statistically significant ($p<.001$) effect on mean weight at most ages. Weights recorded in the wet (July-September) and hot (April-June) seasons were consistently lower than those recorded in either the mild (October, November and March) or cold (December-February) seasons.

As expected the number of siblings alive when a child was born had a significant ($p<.05$) influence upon weight and height after adjusting for maternal age, sex, caste, service group, season and year of observation. Five family categories were considered: (a) 0-1 males, 0-1 females; (b) 2+ males, 0-1 females; (c) 0-1 males, 2+ females; (d) 2+ males, 2+ females; and (e) unknown. Those coded as unknown family composition were thought to be mostly first births, although this could not be verified because of the way family composition had been coded. The percentage distribution of children who fell into these five sibling classifications was 45, 18, 18, 11 and 8 percent, respectively. For every age group those with two or more male siblings, regardless of the number of female siblings, had both lower average weights (mean Δ = 0.28 kg) and lower average heights (mean Δ = 0.9 cm) than those with fewer male siblings. Children with two or more female siblings and two or more male siblings, showed somewhat greater differences, with a mean weight difference of about 0.29 kg and a mean height

difference 1.2 cm less than those with only one or no living brothers. These differences in nutritional status are certainly related to the strong preference for males and to the cultural practice that older siblings take precedence.

Maternal age at the time of the child's birth had a generally strong influence on both weight and height. Four age categories were considered: less than 25 years, 26-32 years, more than 33 years, and a fourth representing unknown age. It was consistently shown that maternal age of more than 33 years had a significant positive effect in producing greater growth and the greatest disadvantage was in children of very young mothers. This effect probably reflects physiological differences as well as relative skill in child rearing.

Effects of Nutrition and Health Care on Growth

As far as we have been able to determine, this research is the first field study that shows a statistically significant difference in growth of children in natural populations as a result of specific nutrition and health interventions and in comparison with controls. In other research projects where similar observations have been attempted either the interventions did not have the expected effect or the controls also improved because of the special attention given to regular measurements.

It has been difficult to portray the composite results of the impact of interventions in any simple set of curves and therefore two sets are presented with somewhat increasing complexity but greater specificity in demonstrating differences. Since growth rates vary markedly at different ages simple growth curves mask some important differences.

Figures 3.3 and 3.4 show mean growth in each of the experimental groups as a percentage of the median Harvard standard at each age from 0 to 36 months.

Figure 3.3

MEAN WEIGHT, RELATIVE TO HARVARD STANDARD, AT AGES 0 to 36 MONTHS, BY EXPERIMENTAL GROUP, ADJUSTED FOR CASTE AND SEX

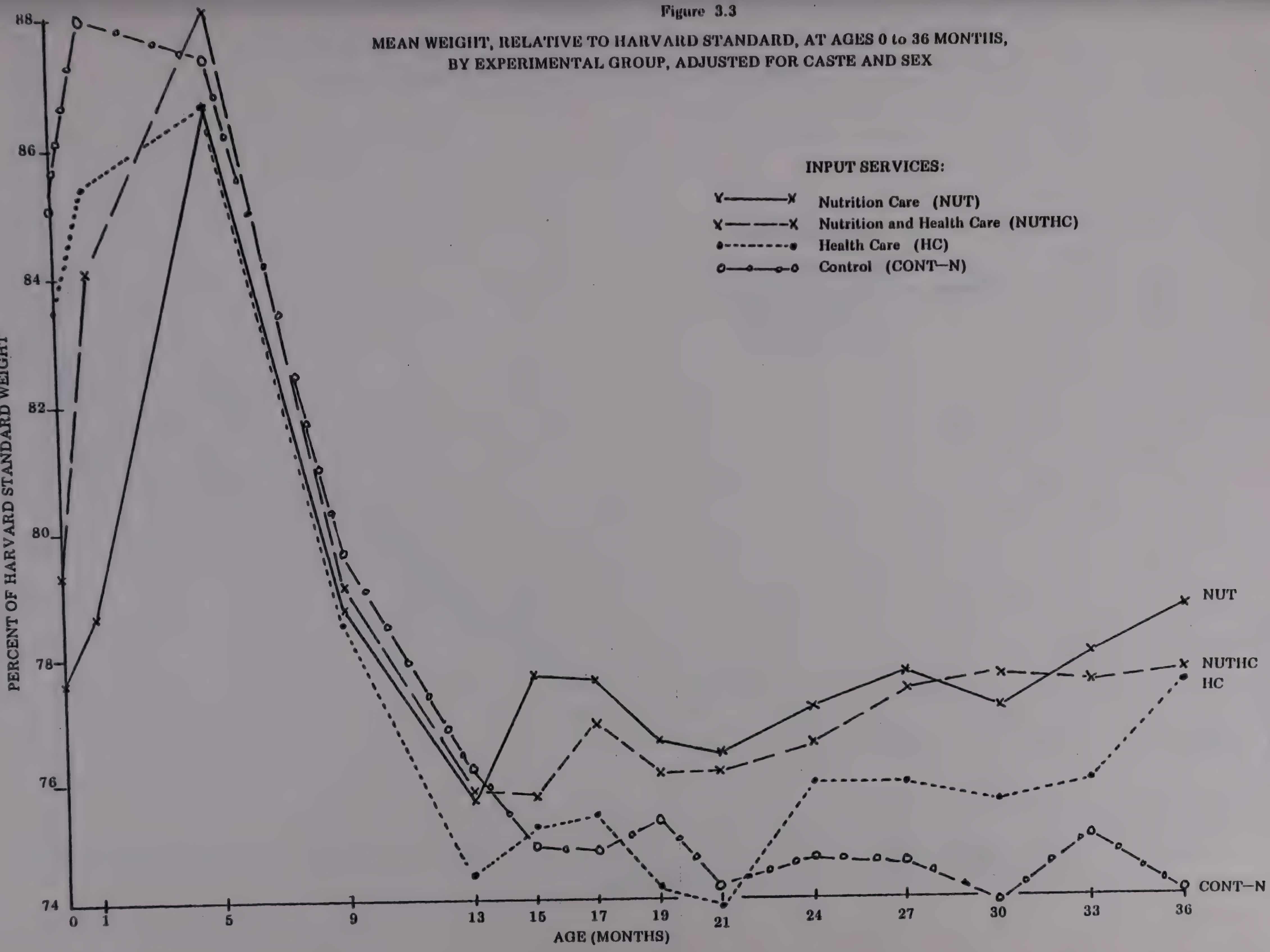
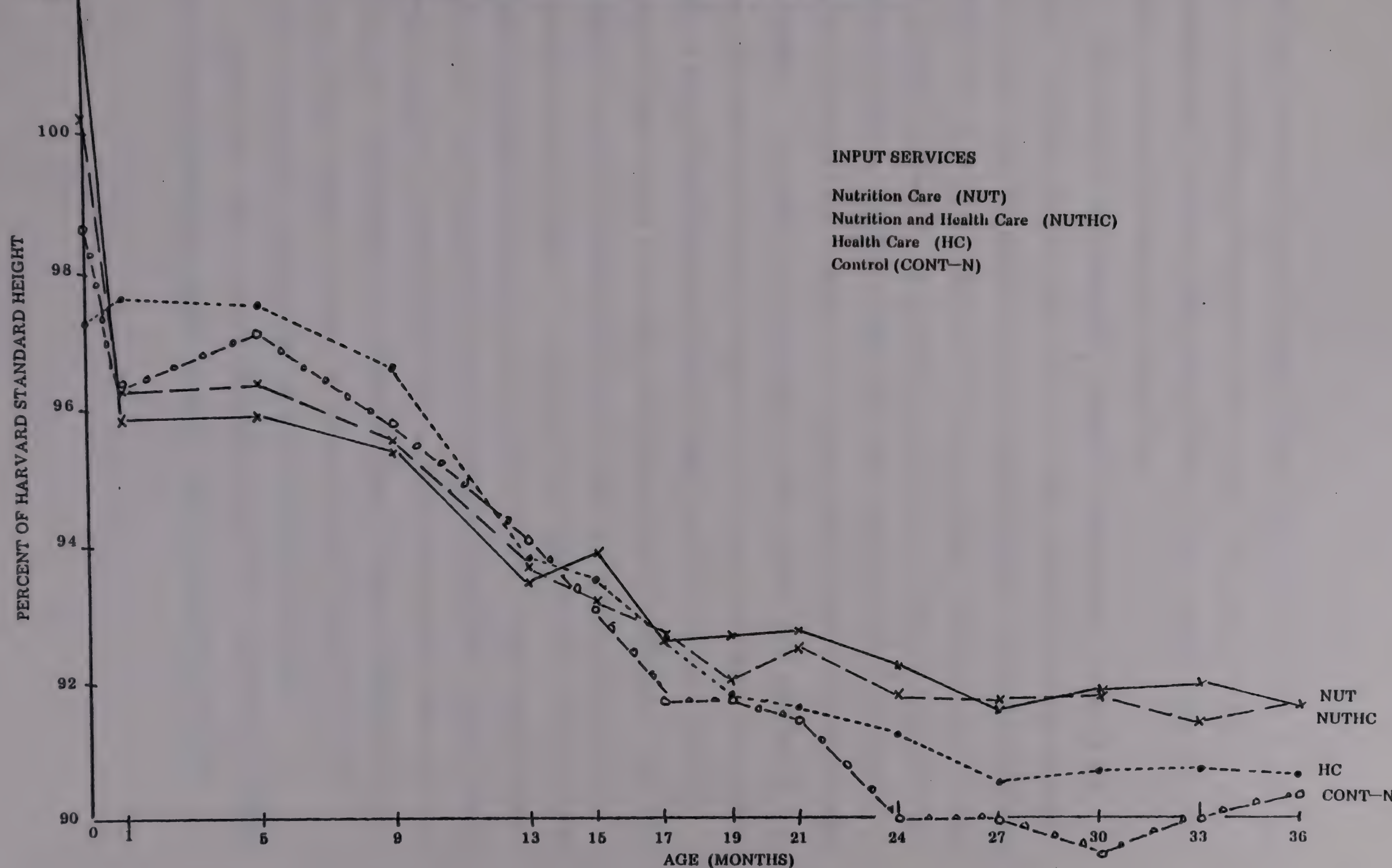


Figure 3.4

MEAN HEIGHT, RELATIVE TO HARVARD STANDARD, AT AGES 0 to 36 MONTHS, BY EXPERIMENTAL GROUP, ADJUSTED FOR CASTE AND SEX



This gives the most accurate picture of where these children were in relation to an internationally recognized index of where they might have been. For comparability, the curves have been adjusted for very unequal caste distribution and slightly unequal sex distribution.

From birth to approximately 13 months of age children living in the control villages (CONT-N) tended to have higher weight-for-age than children in villages receiving nutrition and/or medical services. Their height-for-age, however, was similar to children in service villages. This initial advantage was probably related to the fact that socioeconomic conditions were somewhat better in control villages, making the later shift even more significant. After 13 months of age, however, the greater growth in NUT and NUTHC villages is evident. All weights in experimental groups suggest some catching up but they never reached 80 percent relative to the Harvard standards. The controls show no sign of catching up and seem to have stabilized around 75 percent. Among the experimental groups NUT and NUTHC both start improvement about 15-17 months of age, but in Health Care (HC) villages the catch-up growth is most pronounced after 24 months. By comparison the height curves show a consistent decline as compared with the Harvard standard for the control groups between 0-24 months, with stabilization around 90 percent after that. In the experimental groups the children started with a slight disadvantage compared to the controls but the relative rate of decline from the Harvard standard was less and the curves leveled off around 19 months of age at about 92 percent. Height therefore did not show the catch-up observed with weight.

The next two sets of curves (Figures 3.5 and 3.6) concentrate on differences among experimental groups, using the control group data as a zero

Figure 3.5

EFFECTS OF EXPERIMENTAL GROUPS ON WEIGHT (Kg.) AT AGES 0-36 MONTHS COMPARED TO CONTROLS, ADJUSTED FOR SEX, BIRTH ORDER, MOTHER'S AGE, CASTE, YEAR AND SEASON OF OBSERVATION

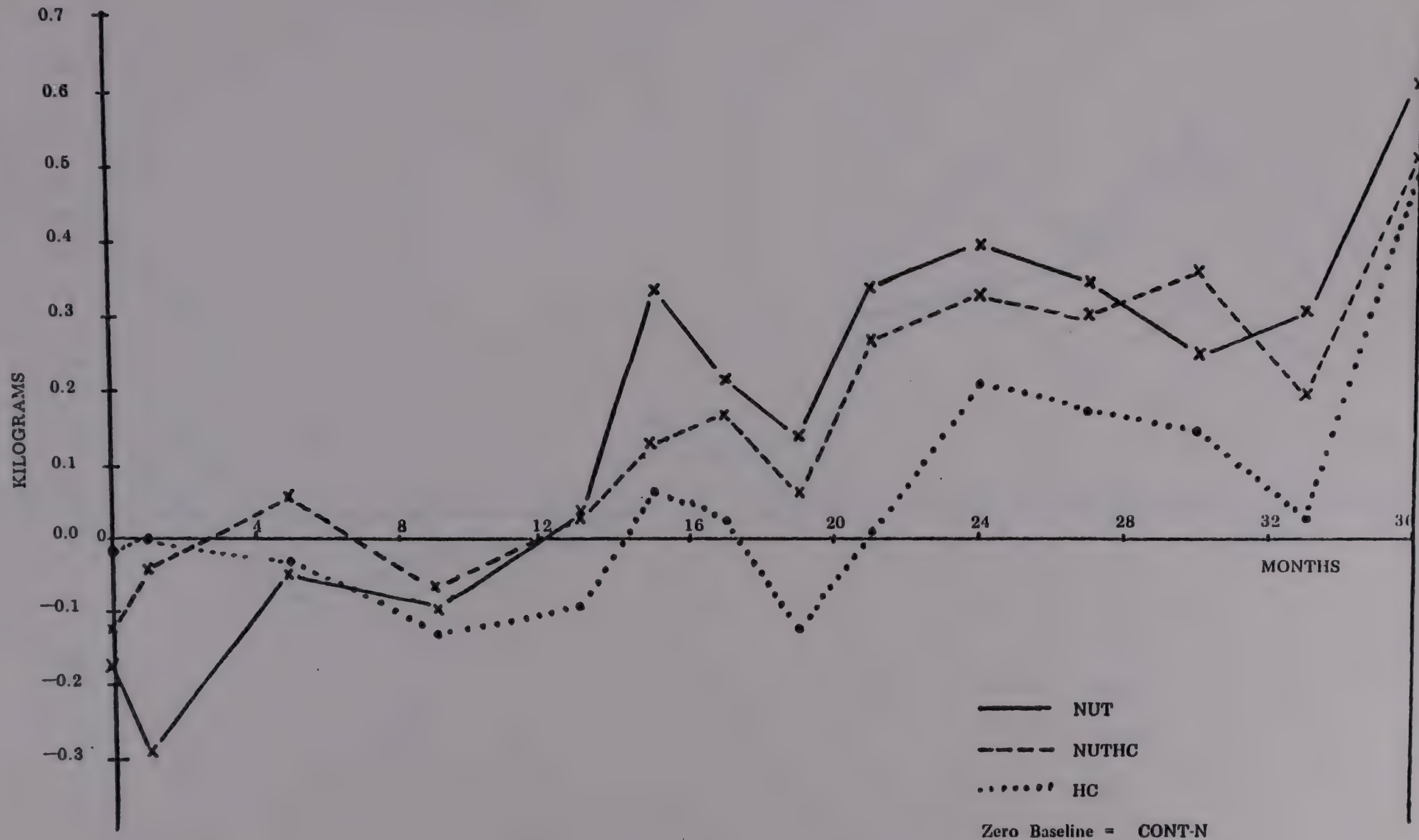
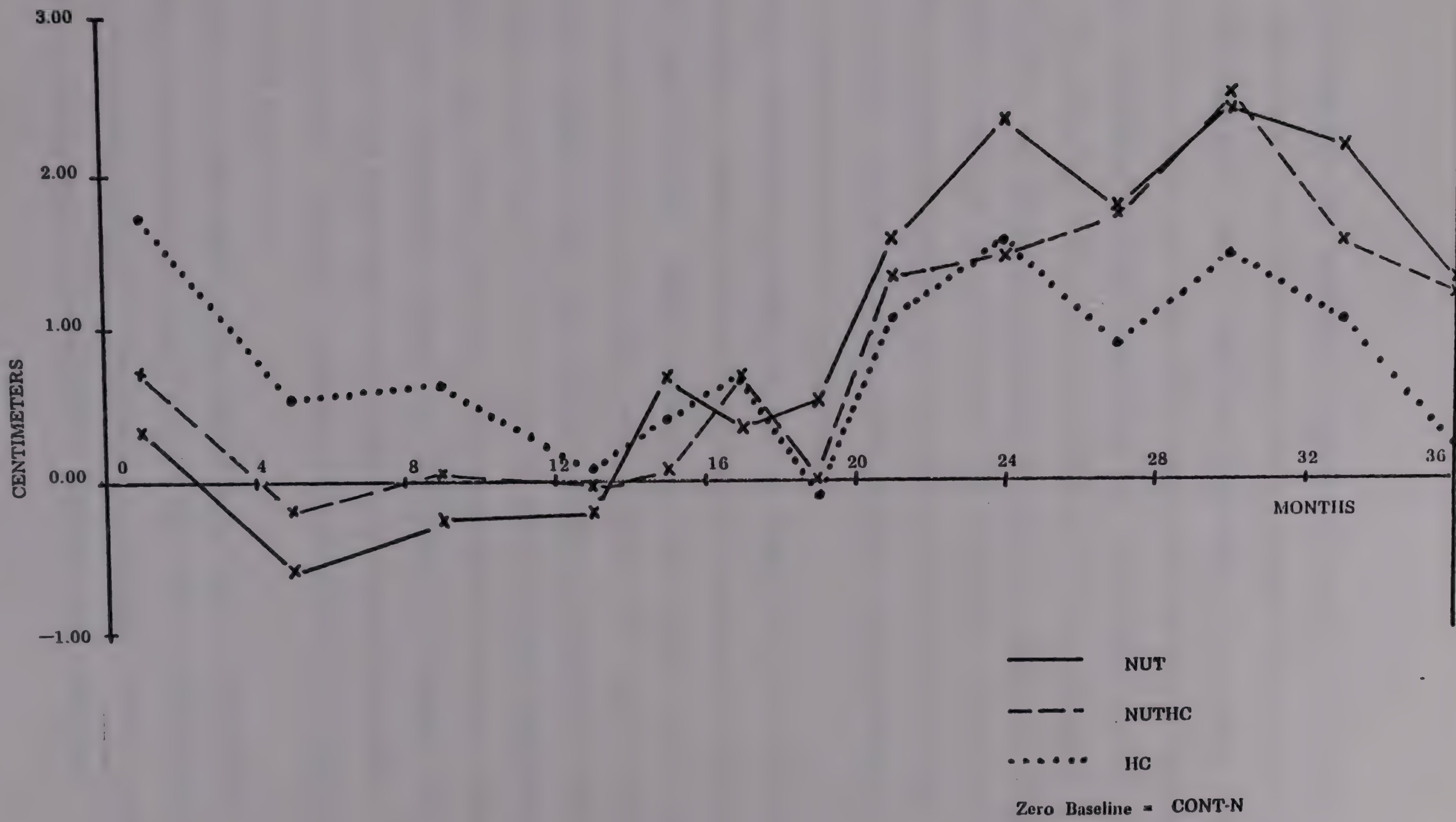


Figure 3.6

EFFECTS OF EXPERIMENTAL GROUPS ON HEIGHT (Cm.) AT AGES MONTHS COMPARED TO CONTROLS, ADJUSTED FOR SEX, BIRTH ORDER, MOTHER'S AGE, CASTE, YEAR AND SEASON OF OBSERVATION



baseline for comparison and expressing differences in physical units (kilograms or centimeters). The fluctuations shown are somewhat exaggerated as compared with Figures 3.3 and 3.4 because of variations in the control curves.

Figure 3.5 indicates that from age 15 months the villages with nutrition intervention maintained a weight advantage of 0.3 - 0.4 kg over control villages; the advantage seems to have increased to 0.5 kg by 36 months. The HC effect was less pronounced and seemed to occur only after the second year of life. For each age group "t" values were calculated and differences in nutrition intervention villages were significant from 15 months onward (t about 2, $p<0.05$). For HC the t values were positive after 21 months of age but did not reach statistical significance.

A similar improvement in height is shown in Figure 3.6, with nutrition intervention having produced average increase of two centimeters in children more than 21 months of age. Again, a smaller but still positive effect was produced by health care with differences being somewhat less than two centimeters after 24 months of age. The apparent reduction in observed differences after 30 months (see Figure 3.4) was in reality due to a modest improvement in the control group which also began to show some catch-up narrowing the gap relative to other experimental groups. The differences in nutrition intervention villages were significant after 21 months of age and became more so reaching $t \approx 3, p<0.05$. For HC the t values became significant at 24 and 30 months of age ($t \approx 2, p<0.05$).

Because of the persistence of observed effects over a range of ages, their composite significance is clearly greater than that exhibited at any particular age. Some caution in interpretation is required, however, because of the lack of independence in the sequential observations; individual

children were included several times in the analysis at different ages since the observations were longitudinal. The seriousness of non-independence can be judged in two ways. First, within any experimental group the striking difference between effects at earlier and later ages suggests that the effects were genuine. If the persistence of effects in the third year of life were due only to repeated observations on the same children, the effects should have been similar at earlier ages. Secondly, the impact of non-independence can be judged by comparing variation among children at a given age with the variation of estimated effects by experimental group between ages after the t-values had stabilized. Such a comparison reveals that variation between ages in a specific experimental group was about 70 percent of the expected variation assuming statistical independence. Thus, while the effect of repeated observations on the same children is important enough to require that the conclusions be somewhat guarded, that effect is not large enough to negate the composite comparisons over all ages from 15 to 36 months. In judging the improvements that occurred it is important also to recall the disadvantageous situation of children in the experimental groups in the first year of life.

Table 3.1 shows the result of the six possible pairwise comparisons. It is clear that "nutrition supplement" is the key discriminator among experimental groups. The difference between NUT and NUTHC is non-significant and these two groups are clearly set apart from the other two. Thus we may rank the groups in terms of statistical significance with NUT and NUTHC showing the best nutrition, CONT-N at the bottom and HC in the middle. In the case of weight, HC is closer to CONT-N; in the case of height it is closer to NUT and NUTHC. These conclusions are weakened by the assumption

TABLE 3.1

COMPARISON OF EXPERIMENTAL GROUPS, UNDER THE ASSUMPTION OF INDEPENDENT SAMPLES, ADJUSTED FOR SEX, BIRTH ORDER, MOTHER'S AGE, CASTE, YEAR AND SEASON OF OBSERVATION

Comparison	df	Weight		Height	
		t	p*	t	p*
NUT> NUTHC	16	0.67	.256	0.45	.329
NUT> HC	16	3.73	.001	1.84	.042
NUTHC > HC	16	3.08	.004	1.39	.092
NUT> CONT-N	8	7.86	.000	5.91	.000
NUTHC > CONT-N	8	6.87	.000	5.27	.000
HC > CONT-N	8	2.39	.022	3.31	.005

* ± .0005

of independence of observations at different ages. But they do not take into account the slight upward trend of weight obervations relative to CONT-N, which is evident in Figures 3.1 to 3.6.

Another way of analyzing the effects of nutrition care is to determine the proportion of children who were malnourished, defined as falling below 70 percent of the Harvard weight median. Up to the age of 11 months villages with nutrition intervention had as many or more children below that level than control villages (Figure 3.7). After one year of age children in villages with nutrition intervention (NUT and NUTHC) had significantly fewer measurements below that 25-30 percent of children were malnourished in villages without nutrition services. In villages with nutrition services the proportion of malnourished children continued to decline from above 20 percent to about 15 percent. The latter were mostly children between 65-70 percent of weight for age but there also remained a hard core of severely malnourished female, low caste children in high parity families.

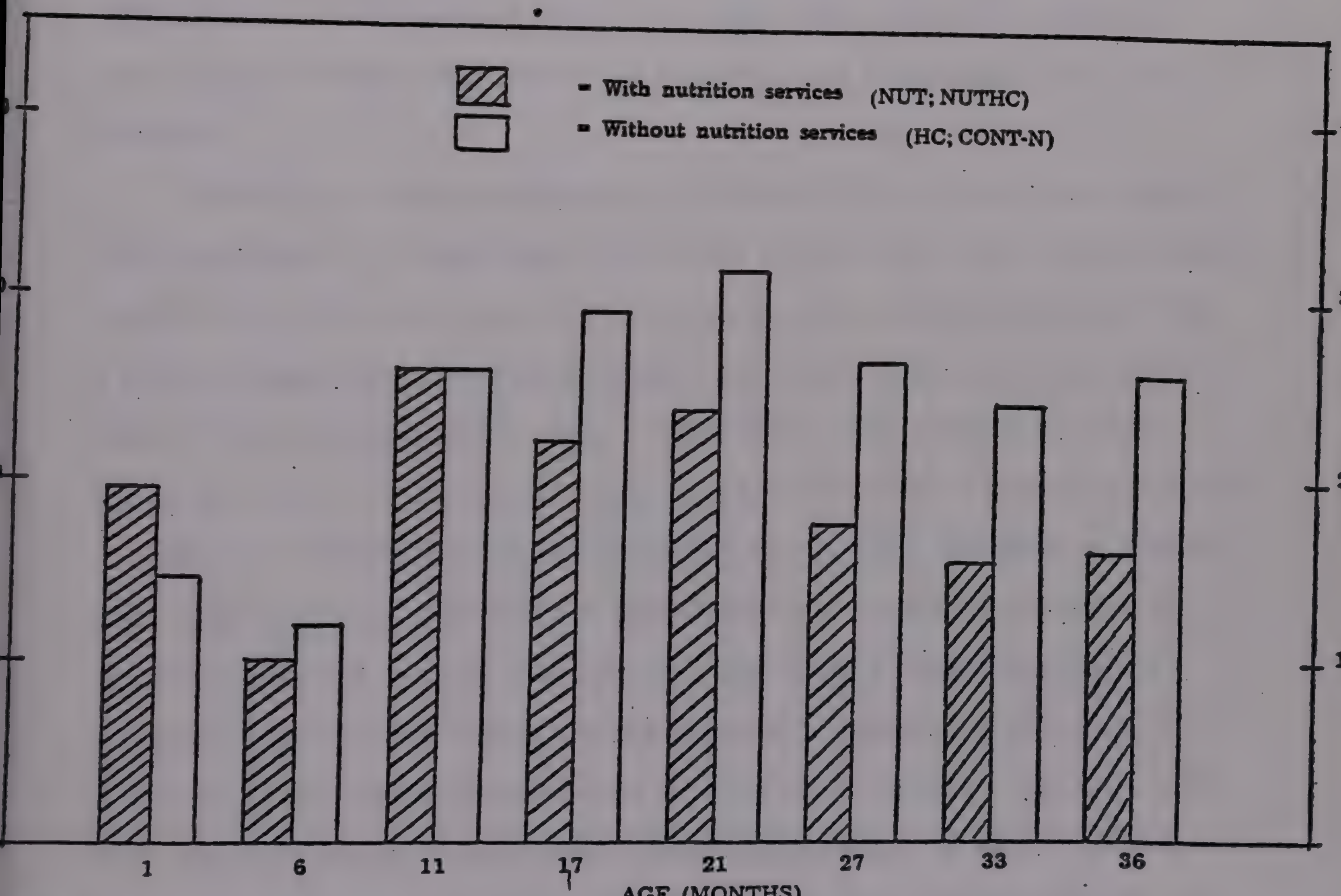
Socioeconomic and Demographic Effects on Growth and Their Interaction with Services

A series of preliminary analyses showed close correlation among the various indicators of socioeconomic status, including indices of income. It was evident that the most useful general index reflecting socioeconomic status was caste. For high caste groups (mainly Jat farmers) incomes and possessions were considerably higher than those of a mid-caste group consisting of non-scheduled Hindus (mainly merchants, priests and civil servants) and non-Jat Sikhs (mainly artisans). These in turn had better economic status than low caste groups (mainly scheduled Hindus and Sikhs, including agricultural laborers,

Figure 3.7

PROPORTION OF CHILDREN BELOW 70% OF THE HARVARD WEIGHT–FOR–AGE MEDIAN BY AGE AND SERVICE INPUT

(Adjusted for differential sex, caste and size of service groups)



Significance : n.s. n.s. n.s. <.05 <.05 <.05 <.05 <.05

leather workers, etc.) who mostly worked for Jats.

Sex and caste each had a highly significant ($p< .001$) effect upon weight and height beyond 17 months of age (Figures 3.8 and 3.9). At various ages males were from 0.6 to 1.0 kg heavier, and from 0.5 to 2.8 cm taller than females, with the largest differences occurring between 5 months and 17 months of age. Beyond the age of one year, high caste (Jat) children were approximately 0.8 kg heavier and 2.0 cm taller than low caste averages. Middle caste averages were about 0.6 kg and 1.5 cm higher than low caste averages.

Interactions between experimental group and sex or caste were generally not significant. A significant interaction between caste and type of intervention occurred at the age of 13 to 15 months when nutrition services had a greater impact upon the height of high and middle caste children than on those of low caste children. This contrasts with the observation that around the age of 33 months all types of services showed a greater proportional effect on the average weight and height of low caste children as compared with other castes. Although these differences may be due to variation in utilization by the various caste groups, the overall comparison probably indicates that it took longer for the program to produce an effect on the nutrition of low caste children than on high caste children, but that eventually special benefit for the most needy was achieved. A single significant interaction between sex and nutrition intervention occurred at the age of 21 months when a greater effect of nutrition care on the weight of males was noted.

Figure 3.8

MEAN WEIGHT AT 17 MONTHS BY CASTE AND SEX, ADJUSTED FOR SERVICE INPUT GROUP, BIRTH ORDER, MATERNAL AGE, SEASON AND YEAR OF OBSERVATION

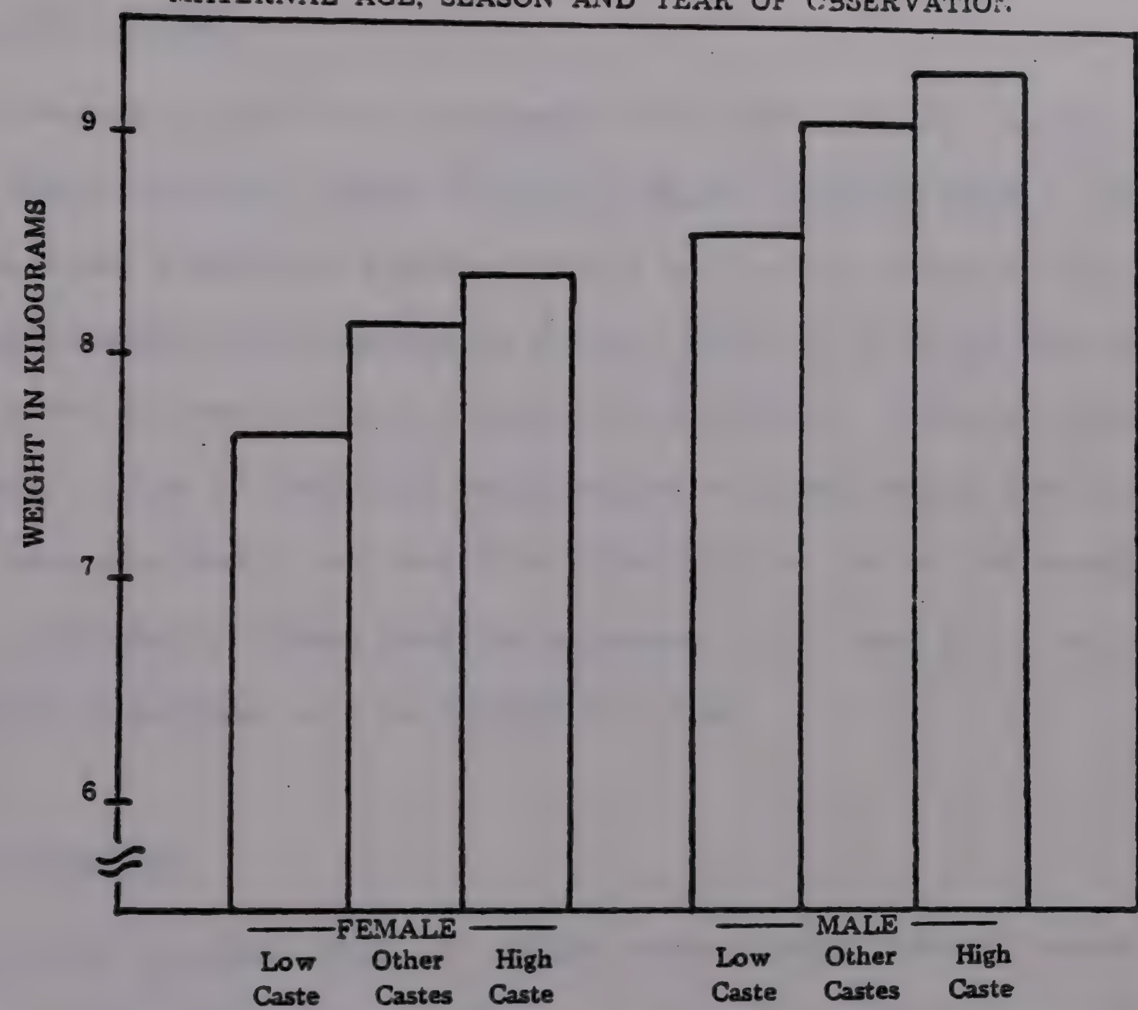
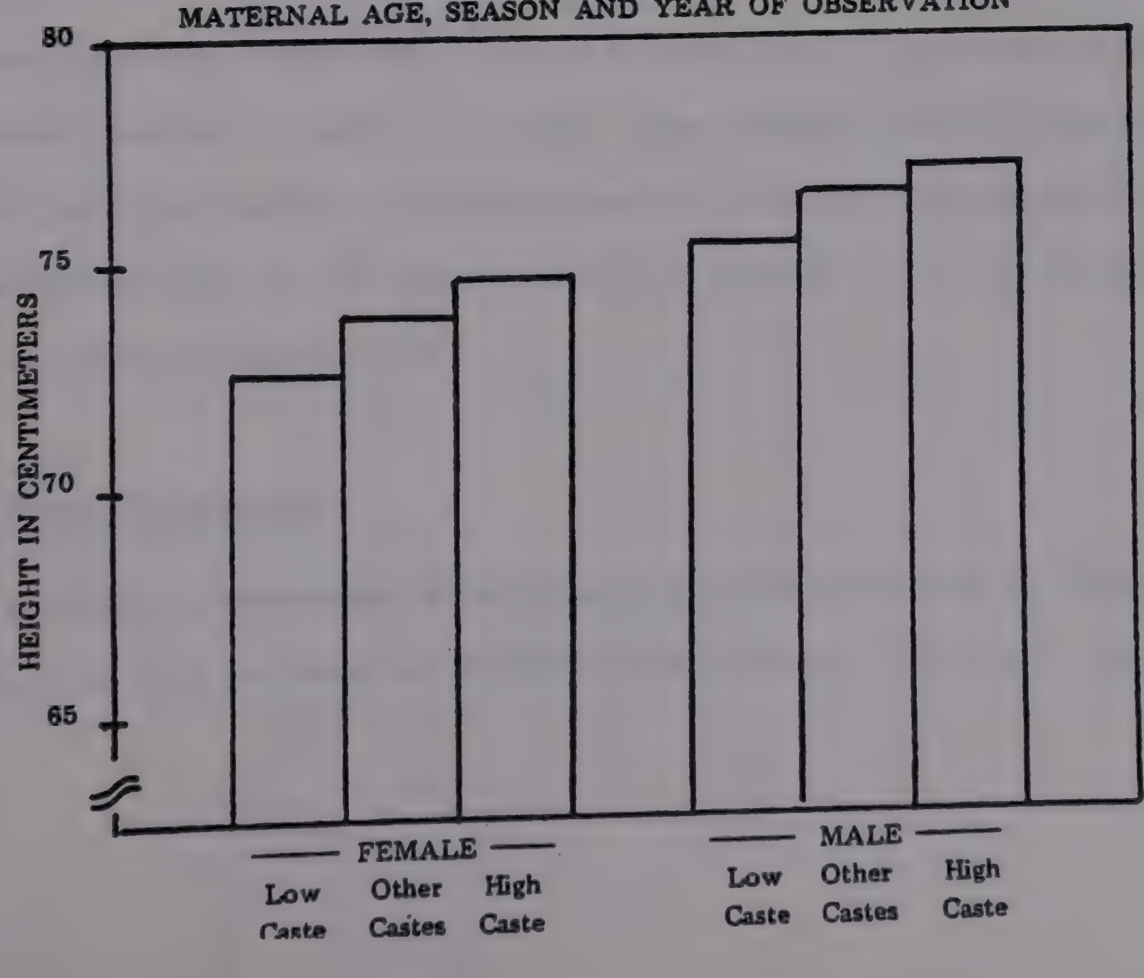


Figure 3.9

MEAN HEIGHT AT 17 MONTHS BY CASTE AND SEX ADJUSTED FOR SERVICE INPUT GROUP, BIRTH ORDER, MATERNAL AGE, SEASON AND YEAR OF OBSERVATION



Hemoglobin Levels

Hemoglobin levels were determined in cross-sectional surveys. The last survey involved almost 80 percent of all children under 3 years of age in the study population and was carried out in the spring of 1971. No age or experimental group reached an average level of 10 gm percent which is considered the borderline for anemia (Figure 3.10). Results showed that children living in nutrition supplemented villages, where iron and folic acid were provided to all children identified as having low hemoglobin levels, had significantly higher hemoglobin levels at all ages above six months than children in medical care or control villages.

Age at Weaning

One of the main functions of the three monthly dietary survey of all mothers with children under three was to provide nutrition education, especially in relation to the time of weaning. At first, the survey was administered in nutrition care villages only. An extremely important component of the health education of mothers was to encourage prolongation of breast-feeding to about 18 months. The records from the dietary survey showed that the duration of breast-feeding in nutrition supplemented villages was significantly ($p<.01$) prolonged by an average of 5.2 months between 1969 and 1970 (Figure 3.11)

Psychomotor Development

A special psychomotor development test was developed by adapting items relating to four psychomotor domains (gross motor, fine motor, language and

Figure 3.10

MEAN HEMOGLOBIN LEVEL BY AGE GROUP AND SERVICE INPUT

(MEAN ± 1 S.E.M.)

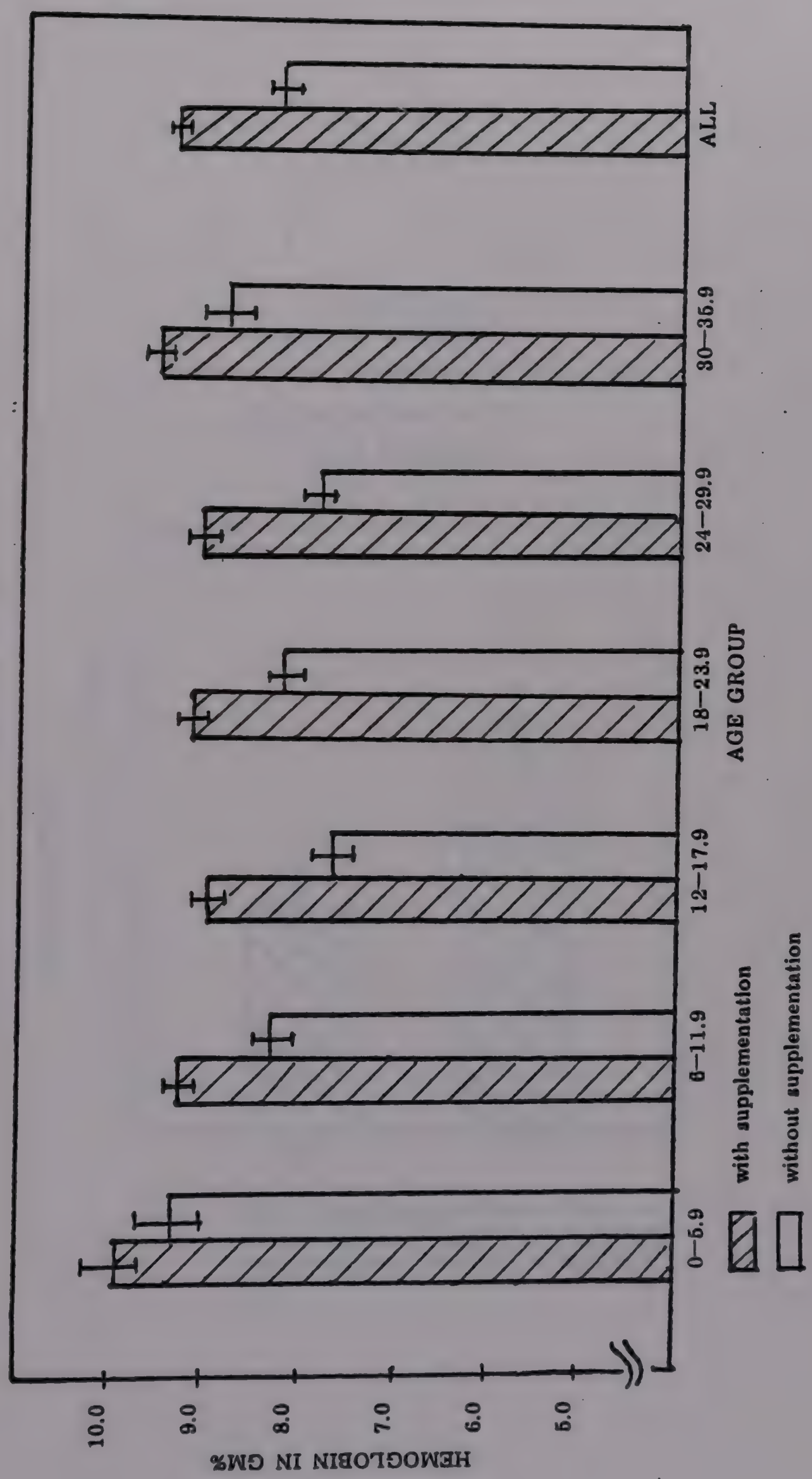
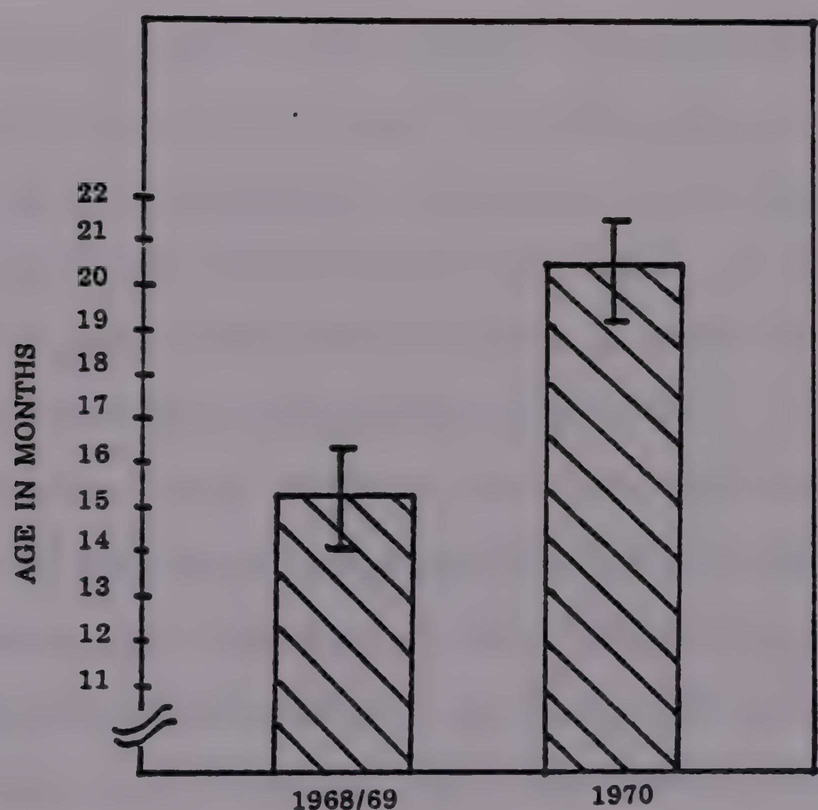


Figure 3.11
AGE AT WEANING*
IN NUTRITION SUPPLEMENTED VILLAGES
IN 1968/69 AND IN 1970
(MEAN ± 1 S.E.M.)



* from: Rural Health Research Centre: Study on the Interactions of Nutrition and Infection Progress Report 1970-1971 (mimeograph)

social integration[1]). After standardization, this test was administered to a sample of 479 study children. For inclusion in the test, children from study villages were stratified according to age and caste groups and then randomly selected. Objectives of the study were to detect relationships of child nutritional levels, family socioeconomic status and demographic variables to motor and cognitive development. For the analysis, a psychomotor index was separately determined for each of the four domains, as well as for an aggregate of the four domains. This was done by dividing the raw score achieved in each of the four domains as well as the aggregate by the median score of all Narangwal children of comparable age who were tested. Multiple linear regression models with the five indices as dependent variables were used to determine relationships and to adjust for confounding variables.

In general, all five psychomotor indices were positively and significantly related to past and present nutritional status. In addition, large variations in nutritional status over the first 18 months of life were associated with low indices of psychomotor development.

More significantly, birth weight and mean weight-for-age over the first nine months of life had a significant and positive effect on psychomotor development. However, the importance of birth weight and nutritional status over the first nine months progressively decreased with increasing age of the child, suggesting that subsequent nutritional intakes compensated for initially low levels of nutrition. Deficits in psychomotor development related to poor nutritional status early in life did not seem to be as permanent in this population as has been suggested in other studies[2].

The relationship between psychomotor development and early and subsequent nutritional status is shown in Table 3.2. This table shows median levels of weight-for-age for the two age intervals used to derive cut-off

TABLE 3.2

MEANS AND FREQUENCIES OF PSYCHOMOTOR INDICES (GROSS MOTOR, FINE MOTOR, COMMUNICATIVE, SOCIAL, TOTAL) BY MEAN WEIGHT-FOR-AGE, MONTHS 0-9, AND BY MEAN WEIGHT-FOR-AGE, MONTHS 10-18

			MEAN WEIGHT-FOR-AGE,* MONTHS 10-18					
			< 75% Mean Index	N	75+ % Mean Index	N	All Mean Index	N
MEAN WEIGHT-FOR-AGE,* MONTHS 0-9	<85%	GM	92.5	140	101.9	28	94.1	168
		FM	93.5	139	101.0	28	94.7	167
		COM	93.0	140	102.7	28	94.6	168
		SOC	89.6	140	104.1	28	92.0	168
		TOT	93.2	139	102.3	28	94.7	167
	85+%	GM	94.9	21	101.6	118	100.6	139
		FM	96.2	21	101.4	118	100.6	139
		COM	96.9	20	101.6	118	100.9	138
		SOC	93.1	21	103.4	118	101.8	139
		TOT	96.2	20	101.9	118	101.1	138
	All	GM	92.8	161	101.7	146	97.0	307
		FM	93.8	160	101.3	146	97.4	306
		COM	93.5	160	101.8	146	97.5	306
		SOC	90.0	161	103.5	146	96.4	307
		TOT	93.6	159	102.0	146	97.6	305

* The Cut-off points for the two different age groups (0-9 months and 10-18 months) approximately correspond to the median levels of weight-for-age for these age groups.

GM = Gross Motor
FM = Fine Motor
COM = Communicative
SOC = Social
TOT = Total

points between "low" and "high" levels of nutrition: these points were 85 percent for children younger than nine months and 75 percent for those between ten and eighteen months, where the reference weights are the Harvard standards[3]. Depending on past weight record, each child was classified into one of the four resulting cells. The mean scores for each of the five psychomotor indices were compared among the cells. The similarity of corresponding means in the two cells for "high" weight-for-age, months 10-18 is striking and suggests that good psychomotor development can ultimately be achieved regardless of nutritional status in the first nine months of life. This same finding was seen in stepwise regression analyses, in which mean weight-for-age for 0-9 months old children was a very significant predictor by itself, but became non-significant when mean weight-for-age for the 10-18 month interval was introduced into the model.

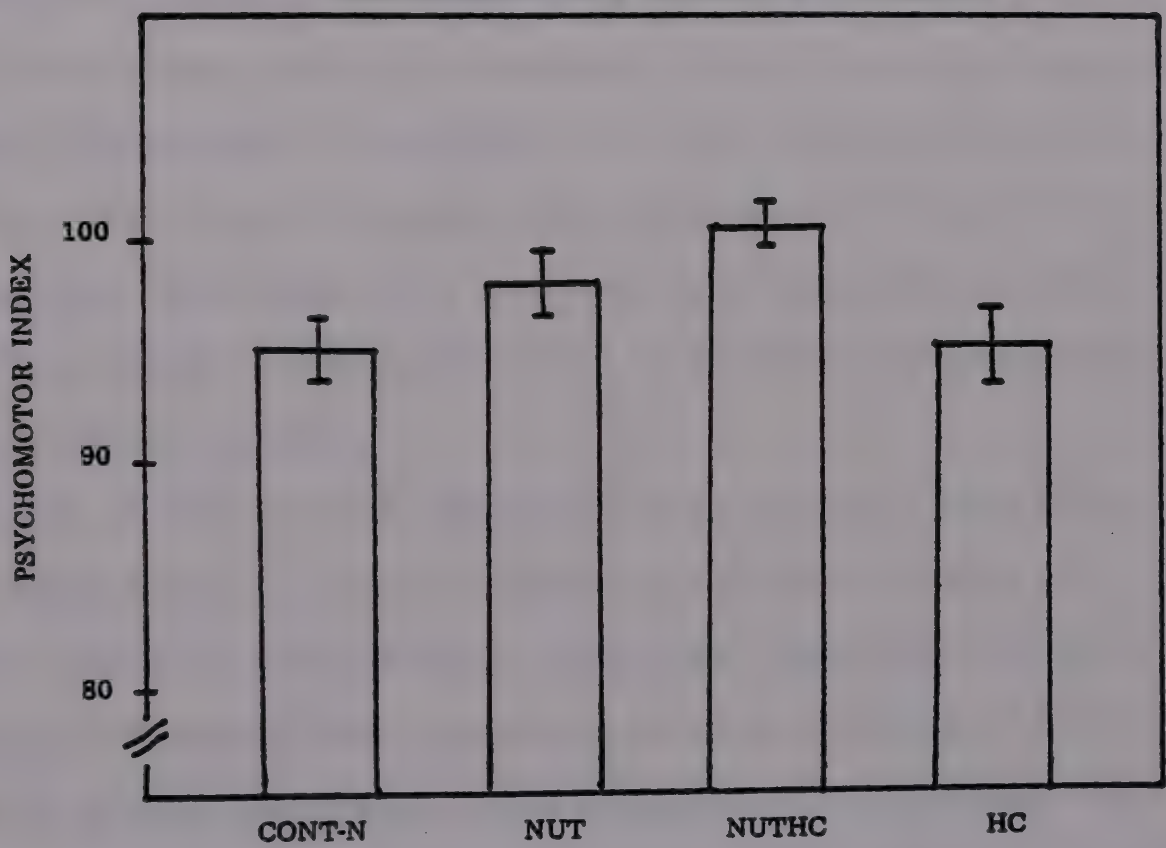
A regression was done to evaluate program effects in the various village groups while controlling for the effect of socioeconomic, demographic and morbidity variables. For gross motor, fine motor and total indices, the effect of NUTHC was significant and generally exceeded the summed separate effects of NUT and HC, suggesting program synergism on psychomotor development. No other separate effects reached significance. For the total index, a child in NUTHC scored on an average 5.22 percentage points more than a child in control villages. For all five indices, except social, NUTHC scored highest, with NUT second. The results for the total psychomotor index are shown graphically in Figure 3.12.

Practical Significance of Interactions

Our analyses of child growth showed an almost equal effect on body

Figure 3.12

MEANS AND STANDARD ERRORS (S.E.M.) OF "TOTAL" PSCHOMOTOR INDEX BY EXPERIMENTAL GROUP, ADJUSTED FOR SOCIOECONOMIC, DEMOGRAPHIC AND MORBIDITY VARIABLES



Difference between CONT-N and NUT = 2.9; "t" = 1.37; p = n.s.

Difference between CONT-N and NUTHC = 5.2; "t" = 2.22 p = $<$ .05

Difference between CONT-N and HC = 0; "t" = 0; p = n.s.

weight and height of caste, sex and the direct effects of nutrition services. The fact these effects seemed to be additive supports the importance of promoting both the provision of direct services to improve nutrition and medical care and general socioeconomic development.

Our results did not show the direct synergism in program effects that the hypotheses and project design had been set up to measure. The combined NUTHC villages had slightly but consistently lower growth curves than the nutrition only villages. This was presumably related to the fact that FHW's in nutrition villages could concentrate on only one set of responsibilities as evidenced by the greater attendance they achieved at feeding centers. On the other hand, both groups with nutrition intervention were clearly superior, while health care villages showed intermediate levels between nutrition and control villages.

The number of live siblings, especially more than two living males, had a signficant effect on levels of nutrition and growth (weight and height). The effect of birth order on nutritional status had been demonstrated earlier by Gopalan[4] who showed that children of fourth or higher order had a 61 percent prevalence of PCM compared to 39 percent for those of the first through third birth order. These findings showing the direct effect of family size on child development confirm the importance of family planning as part of comprehensive care. Furthermore, a fluctuating percent (15 to approximately 25 percent depending on season, sex and caste) of children remained undernourished (arbitrarily defined as below 70 percent of the Harvard median in two consecutive months) even though they were covered by our nutrition services. The observation that these were mostly

low caste girls born into high parity families suggests that further progress in eliminating malnutrition could be helped greatly by making it possible for families to have only the number of children they can support.

Service inputs had no significant effect on average weight before 15 months and on height before 17 months of age. The delayed impact of the feeding program may be partly related to the fact that feeding center utilization* by undernourished children between 6 and 12 months of age tended to be low (averaging 22 percent). According to a longitudinal survey of feeding center attendance over the last 2-1/2 years of the project, utilization rose to 42 percent and 40 percent in the second and third years of life respectively. A deliberate effort was made to encourage families with adequate resources to provide their own weaning food at home because we did not want to create undue dependency on the feeding centers. Overall, Ramdasia (low caste) children attended feeding centers slightly more consistently (41 percent) than Jat (high caste) children (30 percent).

Having shown that care to a total child community can improve average growth patterns, we also have data on whether taller and heavier children were also better off in other indices of health. In Chapter 6 we present data showing that the level of nutrition was closely related to the child's relative risk of dying. Another analysis[5] also showed a significant relationship between nutritional status and morbidity. In a separate investigation we showed that weight-for-age less than 70 percent of the Harvard standard was associated with a significant decrease in nonspecific immune capacity[6].

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* Utilization rates are based on the total feedings received by children in the target group as a percent of expected feedings (expected - 2 feedings per day per child)

Psychomotor development is also associated with adequate levels of nutrition. We found, however, that nutritional deficiency in the range commonly encountered in a rural, ambulatory child community seemed not to be associated with permanent psychomotor impairment. The children's psychomotor development seemed to catch up if nutritional levels improved up to the age of 18 months. It is probable, therefore, that better growth patterns contribute to improving immunity, morbidity, mortality and psychomotor development.

Summary

1. Three variables had major additive effect in improving growth: nutrition intervention, caste and sex. Each variable produced 0.3 to 1.0 kg and 1.4 to 2.8 cam increases in average weight and height. A high caste male from a nutrition care village, therefore, averaged 2.5 kg more in weight and 6.0 cm more in height at 36 months than a low caste female from a control village.

2. Nutrition intervention can increase significantly the weight and height of total populations of children. As far as we can determine, this is the first controlled experiment of total child populations under natural conditions where this has been demonstrated.

3, Health care also produced significant improvement in weight and height of children which was intermediate between nutrition care and control villages.

4. Combined nutrition and health care produced growth essentially equivalent to nutrition care alone but no true synergim of program effects

on growth was observed. Combined services did, however, show a synergistic effect on psychomotor development.

5. After a family had two male children, additional siblings averaged 0.3 kg less in weight and 0.9 cm less in height than siblings of earlier birth order.

6. Average growth in weight and height increased with maternal age, suggesting that "maternal depletion" is not a serious problem in the average Punjabi woman.

7. Nutrition supplementation including iron and folic acid raised mean hemoglobin levels for all age groups above six months of age by an average of one gram percent.

8. Psychomotor performance was influenced by past and present levels of nutrition and also by the amount of fluctuation in nutritional status in the child's past.

9. The practical package of nutrition care that evolved in this project was based on surveillance through regular weighing and measuring of all children. Concentrated efforts were focussed on children showing no increments in growth with primary emphasis on nutrition education of the mother. In addition, children who were underweight were provided food supplements twice a day at village feeding centers and about 40 percent of such children participated in this program.

10. Breast-feeding was prolonged by an average of 5 months through simple but intensive nutrition education related to a dietary survey at three month intervals.

11. All services were provided very effectively by family health workers (retrained lady health visitors) and village feeding center attendants.

12. In spite of the intensive nutrition program there remained a "hard core" group (15-25 percent) of relatively malnourished children, which included mainly low caste girls born to high parity mothers. To get further reduction in the levels of malnutrition it seemed apparent that more effective family planning practice and general socioeconomic development would be necessary.

CHAPTER 3 - REFERENCES

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CHAPTER 4

CORRELATES OF PRESCHOOL CHILD GROWTH IN RURAL PUNJAB

Dov Chernichovsky, Nandita S. Kielmann, Arnfried A. Kielmann and William A. Reinke

Introduction

The purpose of this analysis is to relate the influence of the quality and quantity of diet, the quality of maternal care and general environmental conditions to child growth as measured by weight and height. In this chapter we attempt to isolate statistically the role of children's diets on their growth, and to relate this dietary intake to the family's economic status.

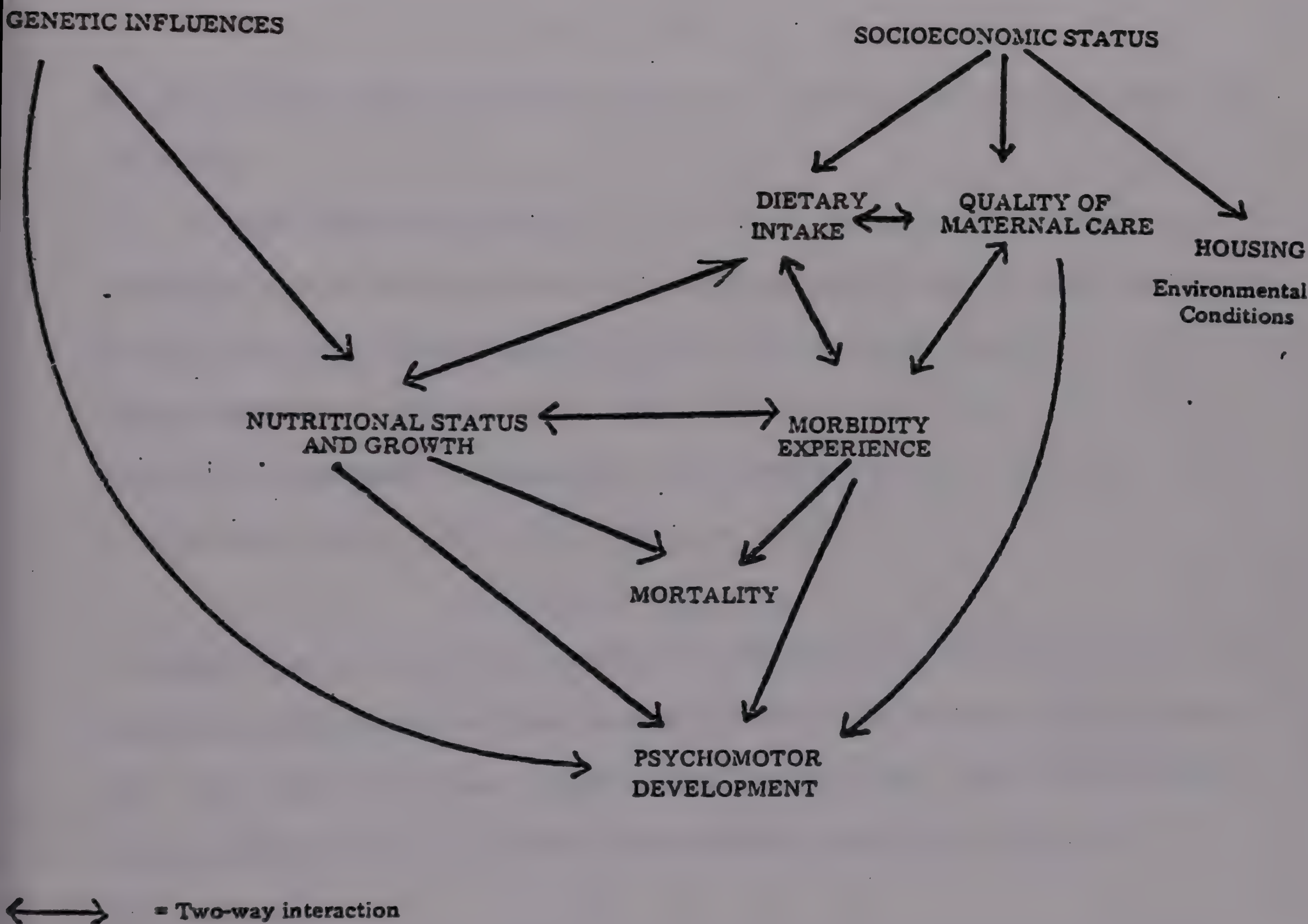
This discussion is based on a sub-sample of 173 children aged 1-36 months on whom detailed dietary intake data were obtained. The discussion falls into two parts. First, we introduce the conceptual framework drawn from Chernichovsky and Coate[1] that is used to analyze the data. Second, in the empirical discussion, we introduce the data, the estimation procedure, and report our results.

Conceptual Framework

The purpose of this section is to formalize the interdependencies among children's growth, health, and their diet (Figure 4.1). From a behavioral viewpoint it is assumed that although constrained by genetic and biological factors parents can, subject to socioeconomic constraints, influence the growth of their children by the choice of diet and by other inputs in their children's health: parental care, sanitary conditions, health care, etc.

Figure 4.1

ANALYTICAL MODEL FOR THE ANALYSIS
OF THE NARANGWAL NUTRITION PROJECT DATA



We begin by relating the initial diet, D_o, of a healthy newborn to birth weight, BW, which is a proxy for an infant's early appetite and muscular development, or initial health conditions, and to socioeconomic conditions, E_o, which determine the quality and quantity of his diet, particularly when the infant is weaned and may be exposed to environmental effects. Formally,

$$D_o = f^o\ (BW,\ E_o). \tag{1}$$

We expect the infant's initial diet to be a positive function of these two variables.

In each subsequent period, t, (t = 1 ... T) the child's growth, G_t, is assumed to be determined by some constant genetic and parental traits, Z, by his diet, D_{t-1}, and health, H_{t-1}, in the preceding period. H_t can be interpreted as an efficiency parameter affecting the body's capacity to process a given diet in the sense that a healthy child makes better use of a given diet than a sick child. That is, formally,

$$G_t = g^t\ (Z,\ D_{t-1},\ H_{t-1}). \tag{2}$$

We expect that the child's growth in each period (age) to be typical of his sex group and similar to some parental traits; for example, taller parents will have taller children. Controlling for age, sex, and parental traits, all represented by Z, we expect healthier children with better diets to grow better.*

The diet in each period, after birth, is a function of the child's growth, which, again, serves as a proxy for the child's appetite, or his

*Parental traits, like height and weight of father and mother are not entirely genetic factors. In a more general and longer run framework than the one described here, parents' growth and development, as their childrens, reflect the parents' own socioeconomic background.

demand for food, and socioeconomic status. Thus,

$$D_t = f\ (G_t,\ E_t). \tag{3}$$

The child's health status is a function of his diet and other factors, like housing and maternal care that are inputs in good health. These other factors are, in turn, also determined by socioeconomic status, so that

$$H_t = h\ (D_t,\ E_t). \tag{4}$$

To identify statistically some key relationships with available cross-sectional data, several assumptions were necessary, some of which are explicit in relationships (1)-(4). First, birth weight was not available for all children within our project because of cultural resistance to early weighing or the fact that about one third of births were in the village of the mother's parents. A more sophisticated model could include birth weight as a variable that is determined by parental characteristics, especially maternal nutrition, as well as socioeconomic variables.

We also assume that some variables, household income and diet, are serially correlated while others, parents' traits and education, are constant. Furthermore, we assume that the time increments are infinitesimal.

These assumptions permit us to derive the following (reduced relationships

$$G = \emptyset_1\ (t,\ Z,\ BW,\ E). \tag{5}$$

and

$$D = \emptyset_2\ (t,\ Z,\ BW,\ E). \tag{6}$$

which relate child growth to parameters that, within this partial analysis, are external to the parents' decision-making process, but nevertheless influence it.

The reduced relationship (5) conceals the particular intervening mechanism, noted in (2)-(4), through which the household's socioeconomic status operates, whether it be diet or other inputs in child health. In particular, (2)-(4) specify the complex interrelatedness of the three main factors of intervention interest: diet, growth, and health. From (2) we see that growth is a function of diet and health, while in (3) we portray diet as a function of growth. Health is in turn a function of diet, as indicated in (4). Taken together, we have the following system of simultaneous equations.

$$\hat{G} = g(t, Z, BW, \hat{D}, \hat{H}), \tag{7}$$

$$\hat{D} = f(\hat{G}, E), \tag{8}$$

$$\hat{H} = f(\hat{D}, E).^{*} \tag{9}$$

In summary, diet, children's growth, and their health are co-determined in the sense that they affect each other, and all are mutually determined by a set of biological, genetic, and socioeconomic variables.

Empirical Analysis

The number of variables measured, and the number of observations of each is inadequate to fully test the model represented by equations (7)-(9). Nevertheless, empirical analysis provides some useful insights, particularly with respect to (7) and (8).

The Data

Relevant available data pertain to a sample of 167 children aged 1-36 months. This sample had to be substantially reduced for parts of the analysis because of a lack of key information on certain variables. Table 4.1 shows the

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*The notation "^" indicates that the variable is an outcome determined by the system of equations.

Table 4.1

MEANS, STANDARD DEVIATIONS AND NUMBERS
OF VALID OBSERVATIONS OF VARIABLES

	Role in (7) - (9)	No. of Valid Observations	Mean	Standard Deviation
Weight (kg.)	G	167	9.53	2.20
Height (cm.)	G	66	79.93	7.36
Calories (gm.)	D	173	1066	420
Calcium (mg.)	D	62	920	591
Diarrhea Prevalence (days)	H	62	0.89	0.68
Age (mo.)	Z	167	24.67	8.11
Sex (male = 1)*	Z	167	0.48	0.25
Maternal Hgt. (cm.)	Z	62	154.26	4.73
Land Cultivator (Yes=1)*	E	167	0.38	0.49
Artesan, Civil Servants (Yes = 1)*	E	167	0.38	0.49
Area of Land Cultivated (hect.)	E	62	2.89	2.26

* A "dummy" variable which equals zero when the condition is not met.

variables available for analysis, their relationship to the conceptual model defined by (7)-(9), and numbers of valid observations, along with the means and standard deviations of each.

These statistics indicate that our sample is equally divided between boys and girls with an average age of two years. These children have an average weight of 9.5 kg which compares with a weight of about 12 kg for a similar group in the U.S. They have an average height of about 80 cm which compares with about 85 cm for the U.S.

Land cultivators who own their land make up 38 percent of this sample, artisans, self-employed and civil servants (teachers, police, etc.) make up 18 percent, and the other 44 percent comprise agricultural laborers. This hierarchy of occupations presents, in a descending order, the relative economic well-being among the groups. This economic well-being is also approximated by the area of land cultivated by each household.

Children's height and weight are growth indicators, the former being a long-term indicator as opposed to more short-term variations for weight.

Consumption levels of calories and calcium were used as proxies for the children's <u>entire</u> diet. Just one of these variables is used at a time because of the high correlation between them. Calcium, which approximated milk protein, appears more significant statistically in estimates that relate to height while calories appear more significant in weight-related estimates. Occupational group and area of land cultivated serve as proxies for socioeconomic status. As is highlighted later on in this discussion, this classification between traits and economic variables may be somewhat arbitrary.

Results

The estimated relationships, which are discussed in this section, represent compromises between our conceptual framework and the available data. We basically assume linear relationships between the outcome variables, nutritional status and diet, and the other variables. We allow for the non-linear growth pattern of children by adding $(\text{age})^2$ to the estimated relationships. The basic conceptual deviation of our estimates from the conceptual framework is because the health indicator is treated as a variable which is not determined by the others.

The estimation procedure comprised two stages. First, we estimated relationships (5) and (6) to establish whether the household's socioeconomic status has an effect on children's growth and their diets. Second, we attempted to estimate part of the system presented by relationships (7)-(9) to particularize the effect of socioeconomic status on child growth through their diet. The results are summarized in Table 4.2.

With respect to the growth analysis (5), the coefficients on children's age variables indicate the common non-linear growth patterns. The coefficients on the sex variable indicate that, on the average, boys are heavier, but not necessarily taller, than girls, It is evident, however, that the sex variable loses some of its statistical significance when maternal height is introduced in the equation.* While in other places the sex variable is often considered a proxy for genetic factors, this variable also represents a known behavioral discrimination against baby girls in this particular environment.

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*The zero-order correlation between maternal height and the child being a boy is .31. This correlation is strangely high and apparently represents a selectivity bias. Taller mothers, who come from higher socioeconomic classes, tended to have their sons rather the daughters receive the treatment of the program. This fact is not apparent in the even age distribution in our sample of children. It may indicate, however, a bias of a small sample.

a. t-statistics for partial regression coefficients

Analysis Number	Ref. Eq.	N	Growth (G) Wgt.	Growth (G) Hgt.	Diet (D) Calories	Diet (D) Calcium	Health (H) Diarrhea Prev.	Genetic and Parental (Z) Age	Genetic and Parental (Z) $(Age)^2$	Genetic and Parental (Z) Sex (boy=1)	Genetic and Parental (Z) Maternal Hgt.	Socioeconomic (E) Land Cult.	Socioeconomic (E) Civil Serv.	Socioeconomic (E) Area Cult.	Adjusted R^2	F
5.1	(5)	167	DV					4.90***	-2.30*	3.93***		3.56***	1.47		.54	37.2
5.2	(5)	62	DV					2.31*	-1.29	1.68*	2.36**	2.30*	1.16		.47	8.2
5.3	(5)	59	DV					1.98*	-0.90	1.38	3.04**			2.00*	.49	10.2
5.4	(5)	58		DV			-1.67*	2.00*	-0.98	1.21	2.10*	2.06**	0.37		.48	8.1
5.5	(5)	57		DV			-1.61	1.07*	-0.75	1.16	2.49**			3.22***	.50	10.2
6.1	(6)	167			DV			2.87**	-1.99*	2.94**		2.73**	-1.00		.19	7.9
6.2	(6)	59			DV			1.16	-1.28	2.15*	1.26			1.31	.13	1.7
6.3	(6)	58				DV		0.08	-0.41	1.51	0.00			2.60**	.13	2.3
7.1	(7)	167	DV		3.24***			1.25	0.08	0.27					.59	45.6
7.2	(8)	167	5.31***		DV							1.17	2.50**		.19	12.3

*p < .05
**p < .01
***p < .001

DV - dependent variable

b. partial regression coefficients

Analysis Number	Dependent Variable	Growth (G) Wgt.	Growth (G) Hgt.	Diet (D) Calories	Diet (D) Calcium	Health (H) Diarrhea Prev.	Genetic and Parental (Z) Age	Genetic and Parental (Z) $(Age)^2$	Genetic and Parental (Z) Sex (boy=1)	Genetic and Parental (Z) Maternal Hgt.	Socioeconomic (E) Land Cult.	Socioeconomic (E) Civil Serv.	Socioeconomic (E) Area Cult.	Constant
5.1	Weight						.34	-.003	.93		.95	.50		2.65
5.2	Weight						.30	-.003	.50	.09	.01	.62		-9.03
5.3	Weight						.25	-.002	.40	.11			.14	-12.88
5.4	Height					-1.99	1.21	-.012	1.92	.15	4.52	.91		1.50
5.5	Height					-1.84	1.07	-.009	1.78	.40			1.00	-4.65
6.1	Calories						48	-0.8	172		180	-80		268
6.2	Calories						50	-1.2	257	16			31	291
6.3	Calcium						5	0.6	255	0			89	929
7.1	Weight			.004			.11	.0001	.17					1.79
7.2	Calories	100									78	-212		121

As expected, maternal height has a positive effect on child growth. Here again, while this variable approximates the effect of genetic and maternal traits, in this environment it is greatly influenced by early nutritional and socioeconomic status. Mother's height is correlated with land ownership (.24), and with area of land cultivated (.18). Therefore, this variable, when introduced in the equation also reduced the statistical significance of the socioeconomic variables.

The effects of socioeconomic variables are of key interest. These variables are represented interchangeably by father's major occupation and by the area of land cultivated by the household. The estimated coefficients indicate that landowners, who are the highest socioeconomic class in this environment, have the heaviest and tallest children. These children have a better nutritional status than the children of a mid-caste group (artisans, self-employed and civil servants) who, in turn, are better off than agricultural laborers. Children of the mid-caste groups appear to grow better than the children of laborers; however, this particular result is not statistically significant. Substituting area of land cultivated for occupation as a proxy for family wealth (analyses 5.3 and 5.5 in Table 4.2) yields results that are consistent with the above findings; children whose families cultivate more land are also nutritionally better off. The estimated coefficient suggests that, around the means, a 10 percent increase in the amount of available land brings about a 0.5 percent improvement in a child's weight, and a 0.3 percent improvement in his height. Alternatively, an increase of one hectare of land cultivated means, on the average, an increase of about 140 grams in the weight, and of about 1 cm in the height of a two-year old child.

Analyses (5.4) and (5.5) in Table 4.2 also show that, controlling for other things, a higher prevalence of diarrhea appears to have, as expected, an adverse effect on child growth as reflected in height.

Relationships assessed in (6.1)-(6.3) are comparable to (5.1) and (5.3) with dietary factors (consumption levels of calories and calcium) replacing growth (weight) as the dependent variables. The results are also comparable, though dietary effects are not as strong as those associated with weight. In particular, older male children of landowners consume more calories than others, as might be expected.

The above results support the conclusion that socioeconomic conditions affect children's growth and diets. They are insufficient, however, for particularizing the effect of socioeconomic conditions on growth through the diet. Relationships (6.1)-(6.3) may overstate the effect of socioeconomic status on the diet in the sense that heavier (and taller) children may eat better, and that some of this effect is captured by the socioeconomic variables. Stated differently, relationships (5.1)-(5.5) showed an association between growth and socioeconomic factors. Since only the latter are included in (6.1)-(6.3), they may indirectly express the effects of growth on dietary consumption.

To overcome these problems, to some extent, we estimated the simultaneous equations reported in relationships (7.1) and (7.2). These equations correspond to relationships (7) and (8) in the conceptual framework that presumes that nutritional status measured by weight, for example, and the diet, measured by consumption of calories, are codetermined; children who eat more are heavier, and heavier children tend to eat more.

This relationship is confirmed. Of special interest to us are the estimates in (7.2). They indicate that for their weight (and age and sex), as determined by all other variables, children of landowners do not appear to get more calories than children of agricultural workers; although, positive the relevant coefficient is not significant statistically in our estimates.* This suggests that when observing two children of equal weight and other measured characteristics, those of landowners have similar diet to those of agricultural workers, at least as far as calories are concerned.

However, for equal weight and other measurable characteristics, children of the mid-caste group (artisans, self-employed and civil servants) get fewer calories. Since we know from earlier estimates that these children grow at least as well as those of agricultural laborers, the results imply that children of the mid-caste groups can grow as well as other children but with a smaller diet. Alternatively, children of parents involved in agricultural activities incur some loss of the diet they consume. This suggests that the lower frequency of infections or lower levels of activity contributes to the growth of children of the mid-caste group. They also had the lowest infant mortality of any caste group (Chapter 6). These factors may be related to better housing and sanitary conditions and childbearing practices. This conclusion, which agrees with our field experience and underlies our conceptual framework, cannot be strictly tested with our data.

Conclusion

While the available data do not permit a full exploration of the conceptual framework we postulate, the results show a clear link between the socioeconomic environment of preschool children and their nutritional status.

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*It is most likely that with a bigger sample, we could achieve superior statistical estimates, showing that children of landlords consume more calories than other groups.

Children of landowners grow better and have better diets than children of artisans, self-employed and civil servants and agricultural laborers. On the other hand, children of the mid-caste group appear able to achieve higher growth levels with smaller diets than children of parents in agricultural occupations. This suggests that artisans (carpenters, masons), self-employed (shopkeepers, goldsmiths) and civil servants (mainly teachers, policemen, etc.) may maintain better sanitary conditions than members of other primarily agricultural occupations, and thus, their children may incur less of a loss in the diet consumed due to infection. This conclusion is supported by other data on the adverse effect of diarrhea on child growth.

CHAPTER 4 - REFERENCE

1. Chernichovsky, D. and Coate, D. "The Choice of Diet for Young Children and Its Relation to Childrens' Growth." New York: National Bureau of Economic Research, Working Paper No. 217, 1977.

CHAPTER 5

ANALYSIS OF MORBIDITY AND MORTALITY

Arnfried A. Kielmann, Cecile De Sweemer, Robert L. Parker and Carl E. Taylor

Morbidity Differences Between Experimental Groups

A critical analysis of the interrelationships between morbidity and nutritional status was an especially important part of this research because these kinds of observations have only rarely been attempted[1]. The amount of work that went into collecting morbidity information overshadowed the rest of the field activities of the Nutrition Project. At the start, great efforts were made to standardize observations through training of family health workers, setting clear diagnostic criteria, and using symptom categories that seemed to fit local concepts of illness.

The experimental design was set up to test hypotheses relating both to incidence and duration of illness and a measurement process was developed to record both. Duration proved to have many fewer measurement problems and was considerably less subject to underreporting than incidence. This was fortunate because from the beginning we had expected to see greater program impact on duration for the following reasons. It was presumed that in the village environment children would be exposed to infections at a continuing high rate and that incidence would not be greatly influenced by the type of health interventions proposed except that nutritional status might have a minor influence on the ratio of clinical to sub-clinical infections.

The immunizations that were provided can only prevent a few specific infections, none of which became epidemic during the period of the study. It was expected that our program of early detection and treatment and improved nutrition would have their main measurable effects by reducing the duration and severity of infections.

In the analysis it became quickly evident that the level of incidence reported was directly correlated with the type of care provided and the frequency of contacts for therapeutic or preventive services. Not only were FHW's more likely to find illness when they were able to do something about it, but also mothers were more likely to report illness if care was being provided. Multiple and complex efforts were made to correct for these fundamental inaccuracies in disease reporting. We had to conclude, however, that incidence results based on mother's reports must always be intrinsically unreliable in comparisons between experimental groups. By aggregating all the group data, however, we were able to get reasonable definition of overall patterns of illness which showed the expected seasonal and ecologic variations.

Underreporting seemed most pronounced for minor illnesses. This assumption is supported by the finding that incidence of severe infections, such as lower respiratory tract infection (pneumonia), was similar in all experimental groups. In order to compensate for this possible bias, we limited analysis to eight symptoms out of the forty-four on which data were collected. The eight that seemed least ambiguous and probably best reported were cough, diarrhea, eye infections, fever, pneumonia (lower respiratory tract infections), skin infections both as pustular rash and skin ulcers,

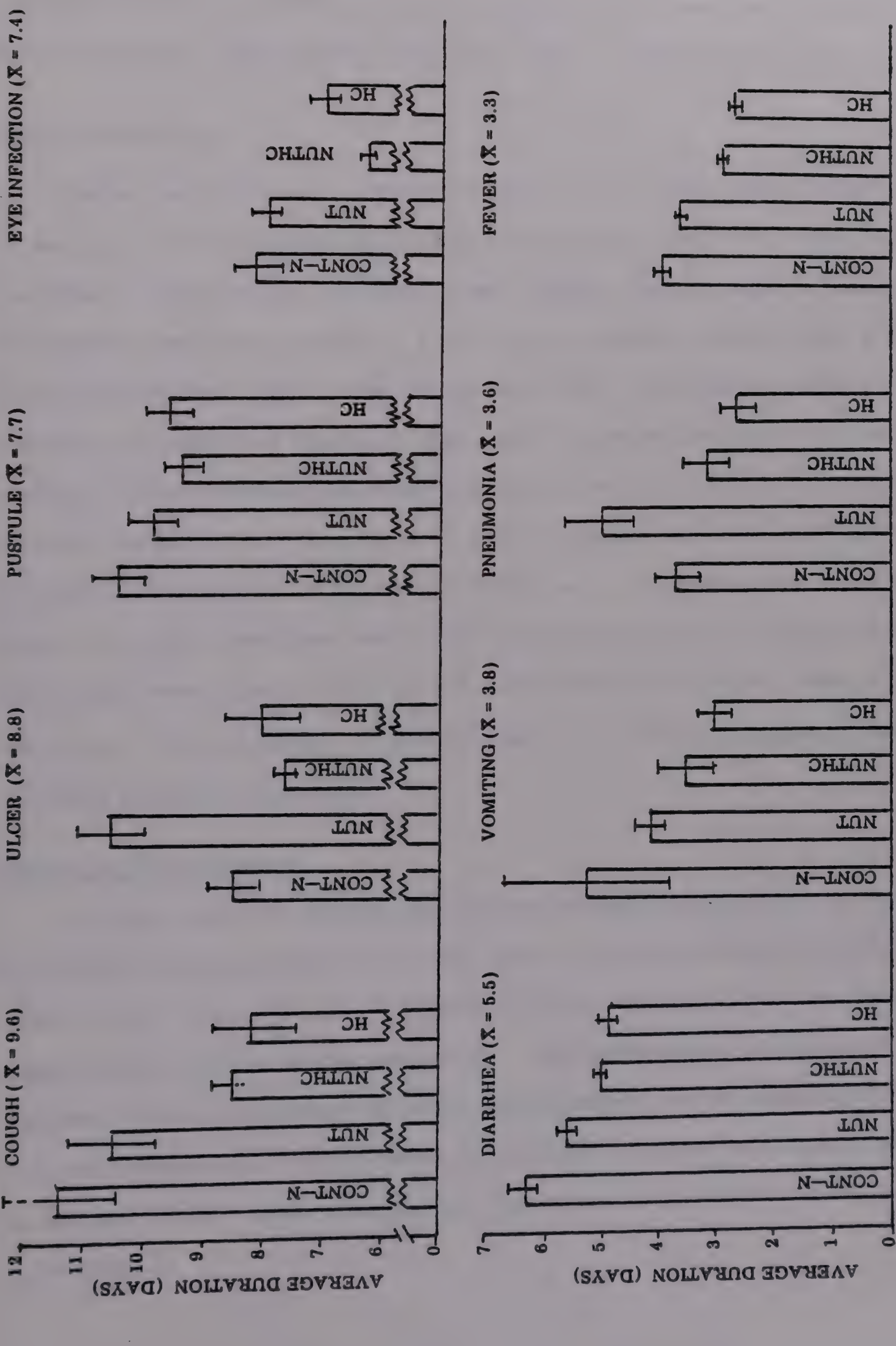
and vomiting. The special importance of these symptoms was as follows: diarrhea, vomiting and pneumonia together accounted for more than 60 percent of deaths in preschool children in this area; eye infections, fever, cough and diarrhea are most prevalent in the preschool population; and skin and eye infections were considered good indicators of hygiene and the quality of child care in the home.

Figure 5.1 summarizes the results of program interventions on the duration of these eight symptoms. Mean symptom duration was adjusted for unequal age and caste distributions in each group as well as for differences in the number of observations at various seasons. Disease episodes were shorter in duration in villages where HC services were provided (NUTHC or HC) than in villages without such services (NUT and CONT-N). Differences were statistically significant ($p \leqslant .02$) for diarrhea, fever, cough and eye infection.

Nutrition care by itself had an intermediate effect on duration. Children in control villages, on the average, had disease episodes of longer duration for all but two conditions (skin ulcers and pneumonia) than children in any of the other cohorts. For these two conditions, children in control villages may have been taken to local private practitioners or the government health center more promptly when they were ill.

In comparisons between the two groups of villages which received health care the only condition in which combined health and nutrition care (NUTHC) seemed to reduce duration significantly more than health care alone, was eye infection. Even though it was only in eye infections that a clear additive program effect was shown, this does not prove that there were no synergistic effects on other

MORBIDITY DURATION BY EXPERIMENTAL GROUP



CONT-N = Control cohort; no services other than emergency care
NUT = Nutrition supplementation only
NUTHC = Nutrition supplementation and health care
HC = Health care

infections because the NUTHC villages also had to overcome the significantly worse health and socioeconomic conditions found in the baseline survey.

Overall Mortality

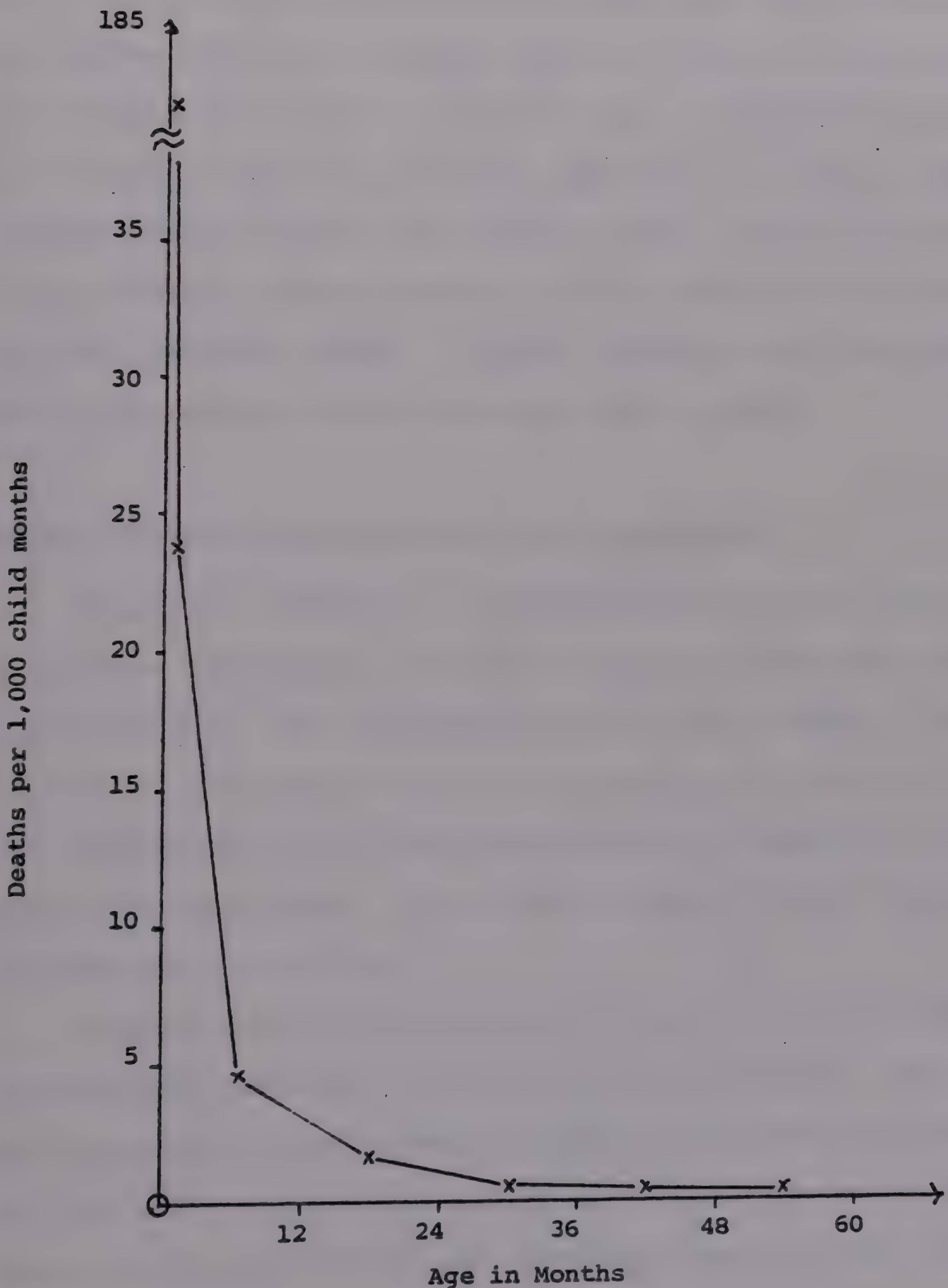
During the four years, 1970-73, a total of 376 deaths up to three years of age and 137 stillbirths occurred in the eighteen study and control villages included in the mortality analysis (these figures include eight villages from the parallel population study). A life table analysis starting with a 1000 live births showed that 41 died during the first seven days of life, 17 between the eighth and thirtieth days, and 44 between the first and twelfth months of life. Between the first and second year of life, 17 more died; between the second and third year, 5 died; between the third and fourth year 4 died; and between the fourth and fifth year 3 children died. The death rate in the first year was about twenty times higher than in the third year and in the second year of life it was about three times higher than in the third year. This decrease in risk of death per 1000 child months of exposure is shown graphically in Figure 5.2.

Deaths by Sex and Caste

In this study the universally observed excess of male deaths in children was found only in perinatal mortality rates. For stillbirths and perinatal deaths males made up 61 and 58 percent of total deaths. After the first seven days females suffered higher mortality. Male deaths were 47 percent of total neonatal deaths, 41 percent of total post-neonatal, and 37 percent of total 1-3 year mortality. For the total period from 0-3 years male deaths formed 41 percent of the total. The excess female mortality reflects local social priorities.

Figure 5.2

RISK OF DEATH PER 1,000 CHILD MONTHS OF EXPOSURE BY AGE GROUP



Mortality of children depends largely on socioeconomic factors and caste was an especially important indicator in these villages. Mortality experience during the first year of life was higher for both the Jat and Ramdasia castes (102 and 116 per 1000 live births respectively) than for a third group made up of a mixed population mostly of artisans, some Hindu merchants, and a few Muslims (67/1000 live births) Table 5.1. This was due to lower perinatal and neonatal death rates in the latter group. Postneonatal death rates from 1-12 months of age were essentially equivalent in all three caste groups ranging between 39 and 48 per 1000 live births. Between one and three years of age, however, Ramdasia children had three times the death rate of Jat children (18 versus 6/1000). Children belonging to the mixed caste group had an intermediate 1-3 year mortality rate (13/1000).

Effects of Health and Nutritional Care on Mortality

Figures 5.3 through 5.7 summarize mortality in the first three years of life for experimental and control villages including data from the parallel population study, four comprehensive care villages (NUTHC-P) and four control villages. In the NUTHC-P villages morbidity surveillance for early diagnosis and treatment was carried out only one-eighth as frequently as in villages of the nutrition project. Data from both sets of control villages were combined for this analysis.

Mortality rates of children under 3 years of age in villages with project services were consistenly lower than in control villages. The reductions were greatest in the experimental villages of the nutrition study proper, and less marked in the child care villages of the population project. This holds true for still birth rates, mortality during the first seven days,

Table 5.1

MORTALITY RATES BY CASTE IN 18 VILLAGES

NARANGWAL, 1970-1973

Caste Group	Perinatal*	Neonatal**	Postneonatal**	Infant**	1-2.9 Years ***
Jat (mostly landholding families)	86	63	39	102	6
Ramdasia (mostly agricultural laborers)	87	68	48	106	18
Other Castes (artisans, Hindu merchants, etc.)	57	25	42	67	13

* per 1,000 live and stillbirths
** per 1,000 live births
*** per 1,000 children 1-2.9 years of age

neonatal, postneonatal, second and third year mortality.

Stillbirth rates were lower in all service villages than in controls. The difference between the stillbirth rates of all service villages combined and control villages was statistically significant ($p < .05$). Stillbirths rates were lowest in NUT villages (24.9/1000 live and stillbirths), a figure less than half the rate in control villages (57.4/1000). The difference was statistically significant ($p < .025$). The next lowest stillbirth rate was in NUTHC villages (36.8/1000) and in the remaining two groups of villages it was 43.8/1000 (NUTHC-P) and 44.6/1000(HC).

Mortality in the first seven days was lowest in NUTHC villages (28/1000 live births), intermediate in HC and in NUT villages (37/1000 live births), and high in NUTHC-P villages (45/1000 live births) and control villages (52.1/1000 live births). This is one of the few instances in which a distinct additive program effect was found with maximum impact appearing in the combined care group of villages. The difference in 1-7 day mortality between the three service groups of the nutrition study and the control group of villages was statistically highly significant ($p < .005$).

Service input effects on total perinatal mortality (obtained by adding stillbirths to deaths in first seven days) are shown graphically in Figure 5.3. The greatest impact again was in NUT and NUTHC villages, with HC and NUTHC-P being intermediate and control villages having the highest rates.

Neonatal mortality rates were reduced equally in all input villages of the nutrition study in comparison with control villages as shown in Figure 5.4. This decline was statistically highly significant ($p < .005$). Villages receiving less intensive combined care in the population study had an intermediate level of mortality reduction.

Figure 5.3

PERINATAL MORTALITY RATES

BY SERVICE INPUT GROUPS

(1970–1973)

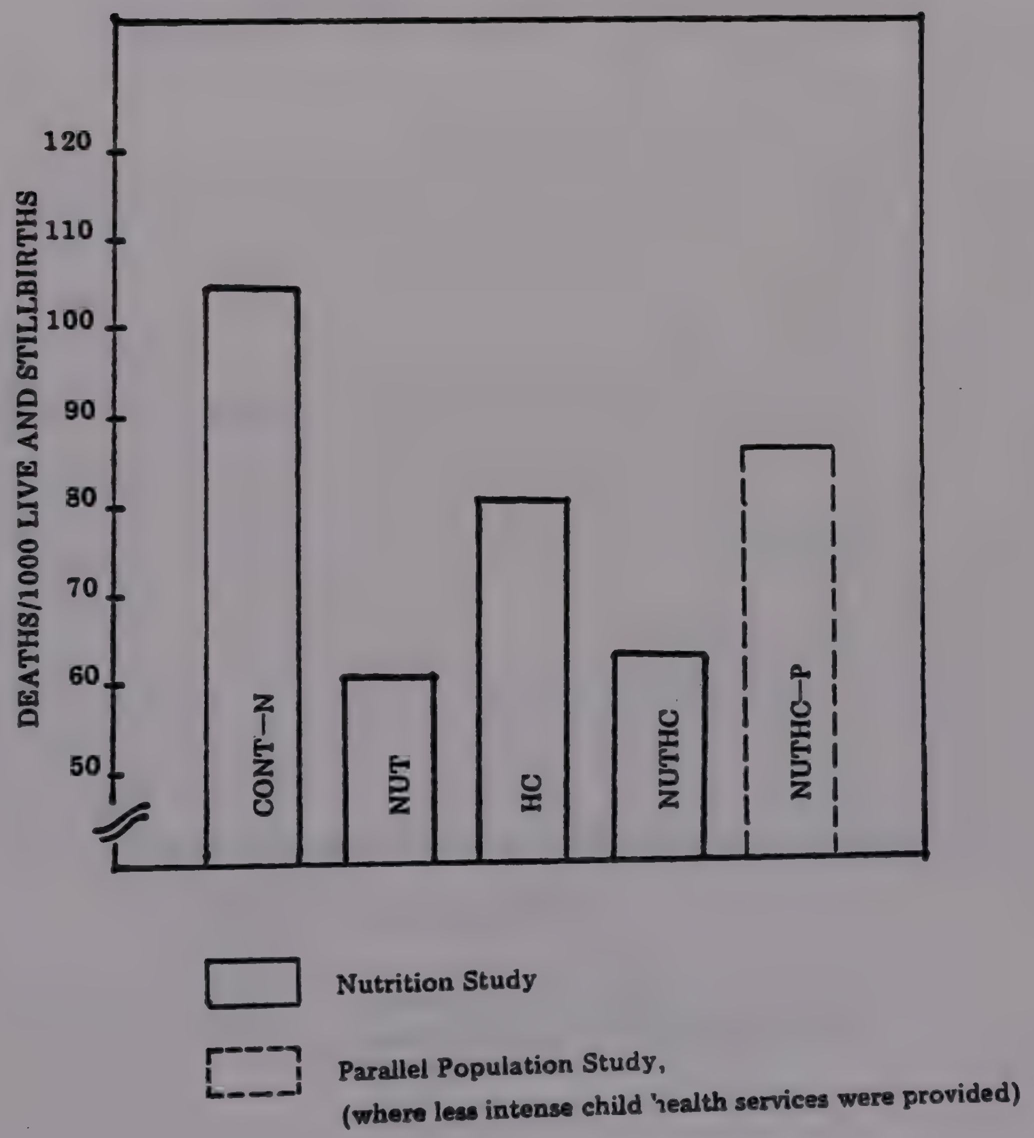
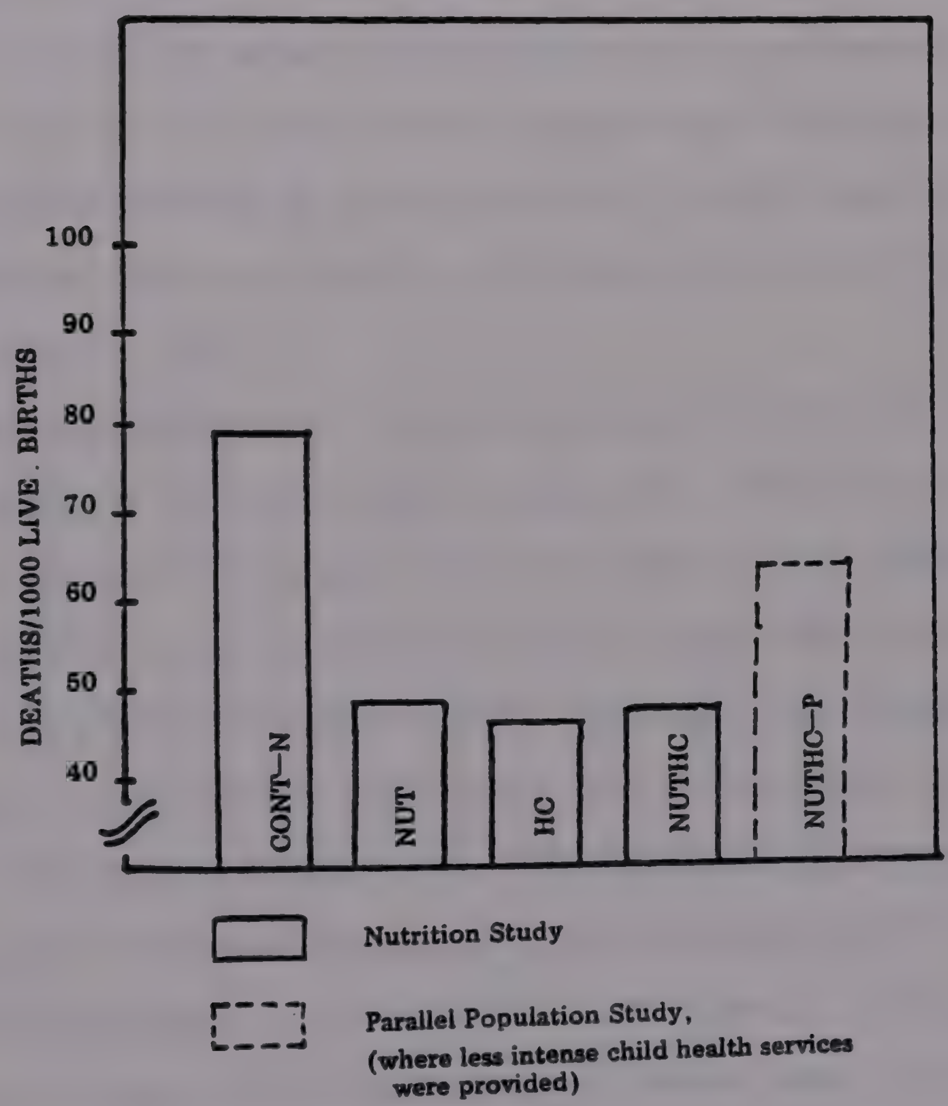


Figure 5.4
NEONATAL MORTALITY RATES
BY SERVICE INPUT GROUPS
(1970—1973)



In the postneonatal period, mortality rates in villages of the nutrition project were most influenced by the provision of health care services (HC 23.3 and NUTHC 35.2 per 1000 live births) as compared with control villages or villages with nutrition care only (about 50/1000 live births) as shown in Figure 5.5. The differences between postneonatal mortality rates in villages receiving health care and control villages was statistically significant ($p \leqslant .05$). Postneonatal death rates in the less intensive combined care villages of the population study showed no change from control levels. We feel that the lack of impact of nutrition care on postneonatal rates may be due to the fact that most babies' nutritional needs were essentially satisfied by breast-feeding up to six months of age and therefore any nutritional impact would have begun to be evident only in the last half of the first year of life.

The infant mortality rate (obtained by adding neonatal and postneonatal rates) was lowest in the health care villages (HC) (70/1000 live births), and second in the health care plus nutrition care villages (NUTHC) (81/1000 live births) and third in the nutrition care villages (NUT) (97/1000 live births). In the population study villages receiving less intensive child care (NUTHC-P) it was 118/1000 live births and in the control villages it was 128/1000 live births (Figure 5.6). The difference in infant mortality rates between the three nutrition project service groups combined and the control group of villages is statistically significant ($p \leqslant .025$).

As shown in Figure 5.7, in the second and third years of life children from service input villages also had lower death rates than those in control villages ($p < .025$). Mortality rates were lowest in the combined

Figure 5.5

POSTNEONATAL MORTALITY
BY SERVICE INPUT GROUPS
(1970—1973)

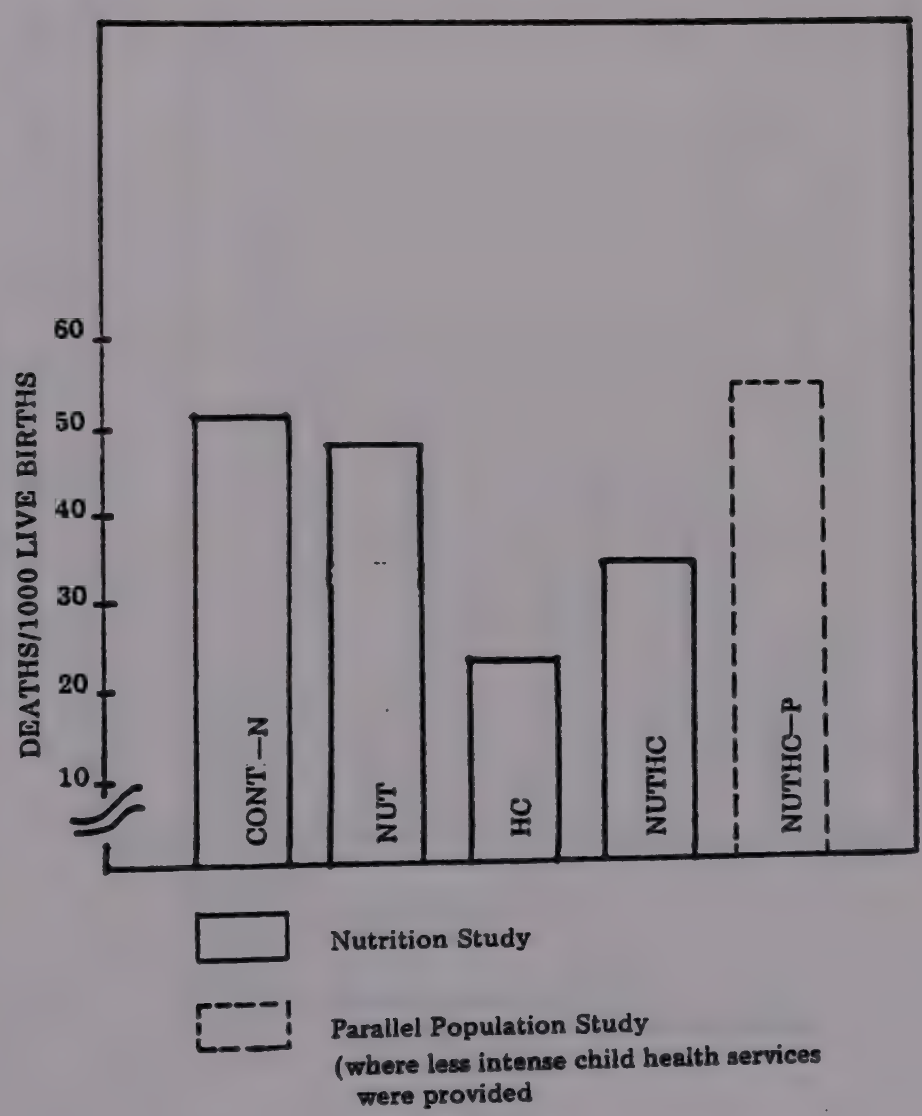


Figure 5.6
INFANT MORTALITY RATES
BY SERVICE INPUT GROUPS
(1970—1973)

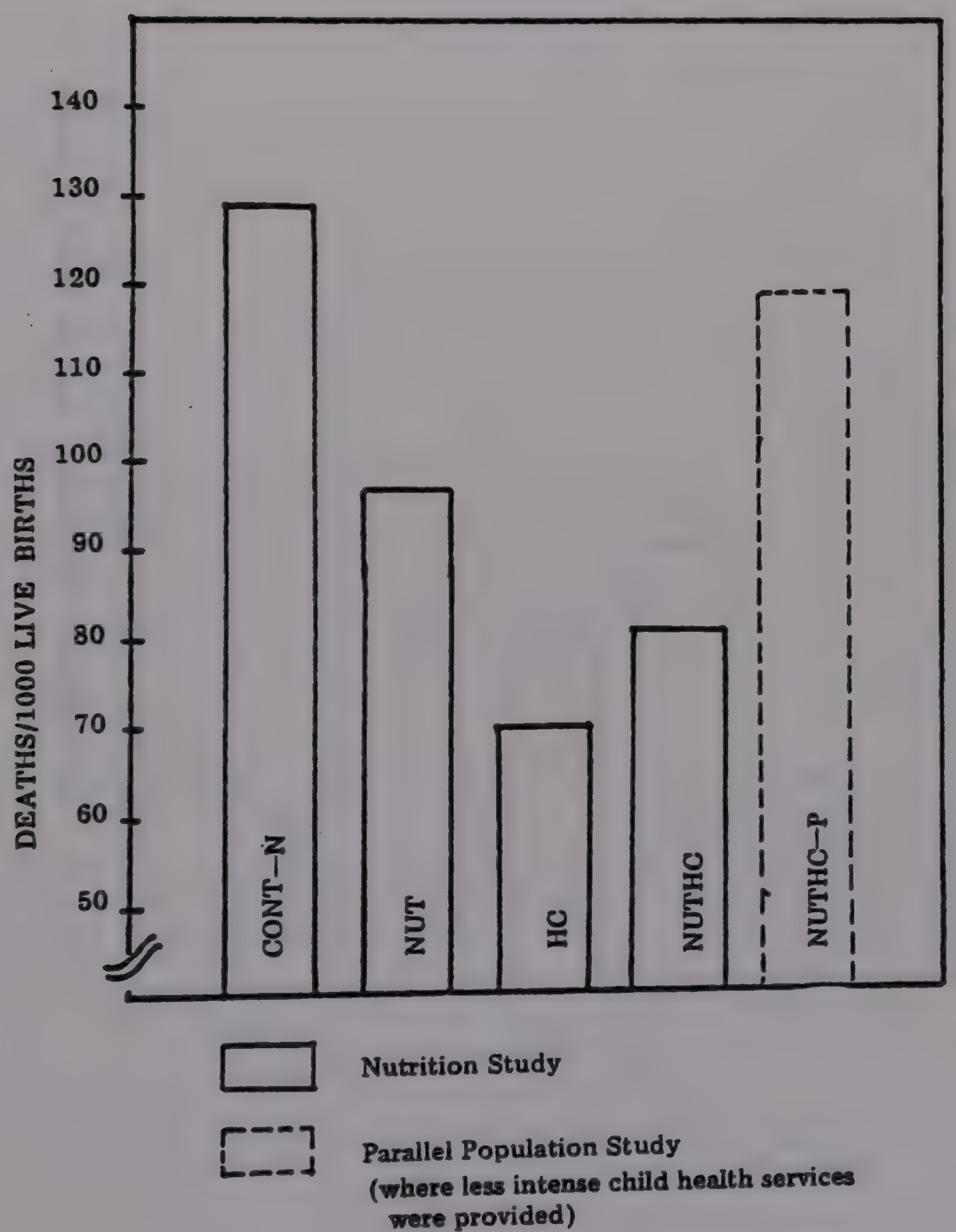
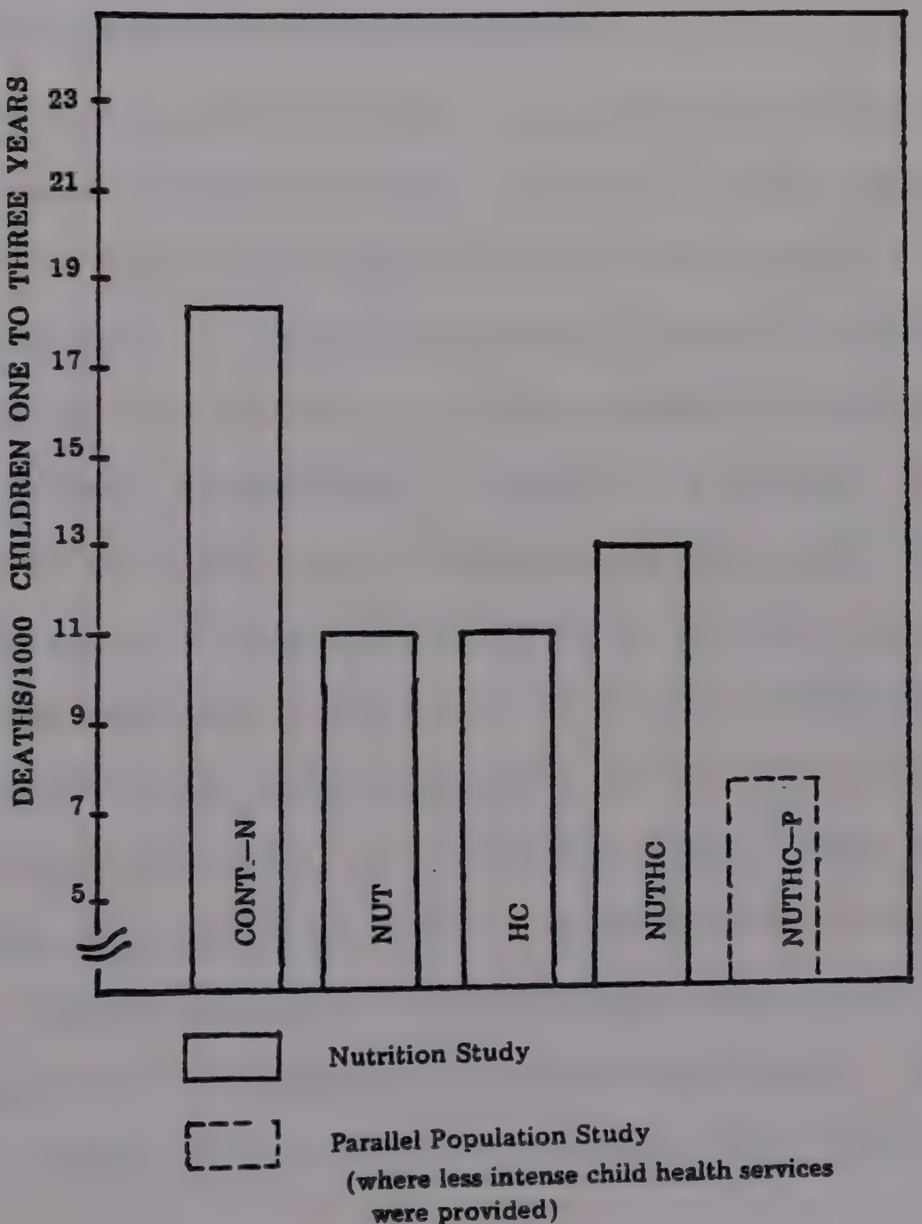


Figure 5.7

ONE TO THREE YEAR MORTALITY RATES
BY SERVICE INPUT GROUPS
(1970—1973)



care villages (NUTHC-P) of the population project (7/1000 population) intermediate in other service villages of the nutrition study (10 to 13 per 1000 population) and highest in the control group of villages (19/1000 population). The differences between experimental groups do not reach statistical significance because of the relatively low number of deaths that occurred in this age range.

Causes of and Circumstances Surrounding Deaths

Two hundred forty-three deaths were analyzed in the Narangwal study for causes and events leading to death. Of these, 124 were perinatal deaths of which about half were stillbirths and 117 occurred between the eighth day and fifth year of life. It should be noted that proportionately the control villages contributed more heavily to the total number of cases than the experimental villages. As described in Chapter 2, a detailed "verbal autopsy" was done, based on the history and all available records, and a presumptive diagnosis of the cause of death was arrived at by consensus among staff physicians. These decisions relied mainly on clinical judgement and because we realized that this might underestimate the role of malnutrition and prematurity as contributory causes, we ran another parallel death analysis using a more statistical approach which is reported later in this chapter.

The verbal autopsy used some of the following definitions:

1. *Prematurity* - birthweight of less than 2000 grams. Prematurity was assigned as primary cause only if no other more likely cause was determined.

2. *Malnutrition* - less than 70 percent weight for age. Malnutrition was only assigned as primary cause when no other cause was apparent. Mal-

nutrition was shown as contributory cause for all deaths where the child was less than 60 percent of weight for age, for those between 70-60 percent of weight for age a clinical judgement determined whether malnutrition was considered a contributory cause.

Table 5.2 shows that for deaths during the first seven days of life prematurity (32 percent), intrauterine asphyxia (19 percent) and birth trauma (18 percent) were the major causes of death. Twenty deaths were clearly related to poor delivery practices or poor child care as follows: nine of the 24 deaths from intrauterine asphyxia were associated with intramuscular pitocin injection during labor by indigenous practitioners; eleven (8 among premature deliveries, 3 among health full-term babies) resulted from accidental aspiration while they were being force-fed by spoon during the first days of life.

In 8-28 day old infants, gastroenteritis, diarrhea, and dehydration were the principal cause of death, accounting for almost a quarter of all deaths, followed by prematurity (21 percent), septicemia (17 percent), tetanus neonatorum (10 percent), lower respiratory tract infection (7 percent) and congenital anomalies (7 percent).

Between 1-12 months of age the primary causes of deaths were gastroenteritis, diarrhea and dehydration - 40 percent; lower respiratory tract infection - 30 percent; and malnutrition - 6 percent. Three deaths, including two from diarrhea and dehydration, were attributable to inadequate health care.

Table 5.3 summarizes the causes of all the 117 child deaths from 8 days to 5 years. Gastroenteritis and/or diarrhea were the primary cause in 43 (37 percent) and contributing cause in 4 (3.4 percent) deaths; lower

Table 5.2

CAUSES OF 124 DEATHS DURING THE FIRST SEVEN DAYS OF LIFE IN NARANGWAL STUDY VILLAGES

Cause	Number	Percent
Prematurity	40	32.2
Intrauterine Asphyxia	24	19.4
Birth Trauma	22	17.7
Congenital Anomalies	8	6.5
Tetanus Neonatorum	4	3.2
Other Neonatal Infections	3	2.4
Other Causes	8	6.5
Unknown	15	12.1
ALL	124	100.0

Table 5.3

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH IN 8-DAY TO 5-YEAR OLD CHILDREN
NARANGWAL, 1970-1973

Cause	Primary Cause			Contributing Cause		
Gastroenteritis, Diarrhea, Dehydration	43	36.8		4	3.4	
Lower Respiratory Tract Infection	20	17.1		5	4.3	
Malnutrition	8	6.8		17	14.5	
Prematurity	7	6.0		4	3.4	
Septicemia	5	4.3		3	2.6	
Tetanus Neonatorium	3	2.6		0	0	
Congenital Anomalies	3	2.6		3	7.6	
Other G.I. Diseases	4	3.4	19%	0	0	20%
Accident (and external causes)	4	3.4		1	0.9	
Other/Miscellaneous	8	6.8		19	16.2	
Unknown	12	10.3		0	0	
ALL	117	100.0		56	47.9	

respiratory tract infection as a primary cause accounted for 20 (17 percent) and was a contributory cause in 17 (14.5 percent); prematurity was the primary cause of death in 7 (6 percent) and a contributory cause in 4 (3.4 percent); septicemia was the cause of 5 (4 percent) deaths and contributed to 3 (2.6 percent) deaths; all other causes were primary in 22 (19 percent) and contributory to 23 (20 percent) of the child deaths. For 12 (10 percent) the cause of death remained unknown.

Seasonal variations were especially important between one and five years of age. Deaths from diarrhea and dehydration and/or nutritional deficiency diseases were highest from April through August (the hot season), when the combined rate for these conditions averaged 11.0 deaths per 10,000 child months of exposure in children aged eight days to five years. Death from these combinations were lowest from November through February with 6.0 deaths per 10,000 child months of exposure and intermediate during the mild season (March, September and October) when they averaged 9.5 deaths per 10,000 child months of exposure. Deaths from lower respiratory tract infection and/or fever and septicemia were high during the cold (November through February) months with 5.5 deaths per 10,000 child months of exposure; intermediate (4.5 per 10,000 child per months of exposure) during the mild months and low (3.5 per 10,000 child months of exposure) from April through August. Seasonal differences by age groups showed that neonatal mortality was high during July through October (rainy season), mortality for 1-11 month old children peaked between May and June (harvest - hot season), and for 12-36 month old children deaths occurred most often from March through April (pre-harvest - hot season with low food availability).

When mothers of the children who died between 8 days and 5 years of age were asked for their opinion of the cause of death, 97 out of 117 mentioned a specific cause. Of these, 74 (64 percent) made the same diagnosis that was made by project physicians through the "verbal autopsy." Supernatural reasons were given as cause of death for 21 (18.3 percent).

Among these same 117 deaths, it was found that the proportion who had previously had a sibling die was significantly higher (45 percent) than for the general child population (22 percent) enrolled in the nutrition study.

Birth order and mortality seem most clearly associated at seventh and higher birth order. The birth order of dead children were as follows: 21 percent were first, 16 percent second, 14 percent third, 14 percent fourth, 8 percent fifth, 9 percent sixth, and 20 percent seventh or higher birth order. The proportion of children of seventh or higher birth order was, however, almost two times greater among dead children than among the total child population (19.7 percent versus 10.4 percent).

A simple indicator of family access to care and availability of services was whether any medical care from any source was provided for children during the illness from which they died. There was information on the timing of such care in 95 of the deaths. (Sudden deaths or children for whom the time of care was not specified were excluded.) Fifty-eight percent of the children received care within 24 hours after their parents realized they were ill. Seventy-seven percent received care within three days of the onset of their illness (including those receiving care in the first 24 hours), 17 percent had some form of care only after they had been ill three or more days, while six percent never received care. If sudden deaths such as accidents are

included in the analysis, those never receiving care would rise to 18 percent. Twenty-four out of 50 female children (48 percent) received care in the first 24 hours of their terminal illness in comparison with 29 out of 45 male children (64 percent) who received early care.

Among 31 deaths in high caste (Jat) families 21 (68 percent) of children received care within 24 hours of the onset of illness. This contrasts with 22 o 45 (49 percent) in low caste (Ramdasia) families and 12 of 19 (63 percent) among other castes. Caste differences in seeking early care were found equally in villages where project services were and were not available. This clearly demonstrates the persistent social, cultural and economic barriers to timely use of services even when they were available right in the village. The classic example is the demand put on the low caste mother at harvest time when economic survival of the family may have taken precidence over seeking care for a sick child.

Obtaining health care for children who died was strongly associated with the age and nutritional status of the child. For children who died at or less than one month of age only about half received care, but 87 percent of children 1-11 months and about 80 percent after the first year of life obtained medical help. Fifty-nine percent of severely malnourished children (less than 50 percent of the Harvard weight median) who died received treatment compared to 86 percent of children who were above 50 percent of the Harvard median ($p < 0.025$). This suggests that the families with the most malnutrition were also not making the best use of available services.

As a potential influence on motivation for family planning there is interest in whether parents deliberately replace children who die. In the course of "verbal autopsies" parents were asked whether they intended to

have another child. Ninety-five percent of mothers who had no or only one living child said they intended to have another child, compared to 54 percent of those who had two to three living children, and 11 percent who had four or more living children. None of the mothers who had three or more living sons said they intended to have another child. No association was found between positive responses and the sex, age, nutritional status of the deceased child, or socioeconomic variables relating to the other or family.

Nutritional Status and Child Mortality

The nutritional status immediately prior to death was known for 95 of the 117 "verbal autopsy" children under three years of age. Twenty (21.1 percent) were at or above 80 percent of the Harvard weight median. Fifteen (16.8 percent) were between 80 percent and 70 percent, 19 (20 percent) were between 60 and 70 percent of the Harvard median, and 41 (43.3 percent) were below 60 percent. This compares to an average distribution among all Narangwal study children of 44 percent at or above 80 percent of the Harvard weight median; 37 percent between 80 and 70 percent; 15 percent between 60-70 percent of the Harvard weight median; and 4 percent who were below 60 percent of the median. This clearly demonstrates that the risk of dying increases sharply under 70 percent of weight for age and is particularly pronounced under 60 percent. Of the 41 children who were below 60 percent of the Harvard weight median and died, 31 (76 percent) were female. By contrast, of the 20 children whose nutritional status at death was 80 percent

or higher, 11 (55 percent) were male (Table 5.4).

At low levels of nutrition (below 60 percent of the Harvard weight median) diarrhea and dehydration proved to be approximately 1.7 times more frequent as a cause of death than in better nourished children (Fisher's exact test-p =<0.14). This difference is important especially in that it shows the specific synergism of diarrhea with the type of marasmus that represents the main nutritional problem in the Punjab. By contrast, among children at or above 70 percent of the Harvard weight median, lower respiratory tract infection as a cause of death was 3.7 times more frequent than among more malnourished children (Fisher's exact test-p =<0.05).

In order to assess quantitatively how much undernutrition contributed to other causes of death we calculated the relative risk of death at various levels of nutrition for all the children in the nutrition project. For these risk calculations we had data on almost 3,000 children. In order to reduce the bias introduced by including children who had low weights because of the disease from which they died, we averaged the nutritional level over several months prior to death. Specifically, the longitudinal anthropometric record of each Narangwal study child under observation between January 1970 and December 1973 was divided into individual child month records according to age and weight-for-age. The three age groups were 1-5.9 months; 6-11.9 months; and 12-34.9 months. Four nutritional classifications were used: below 60 percent weight-for-age; 60-69 percent; 70-79 percent; and 80 percent or more. For those who died between 1-2 months of age, weight at or near birth was used. Child months for all children were then aggregated according to age and nutritional groups. The risk of death for each age and nutritional group was determined by dividing the number of deaths in each

Table 5.4

NUTRITIONAL STATUS AT DEATH BY SEX OF DEAD CHILD

Sex	Nutritional Status (% Harvard Weight Median)									
	< 60		60-69		70-79		80+		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male	10	24.4	6	31.6	6	40.0	11	55.0	33	34.7
Female	31	75.6	13	68.4	9	60.0	9	45.0	62	65.3
All	41	100.0	19	100.0	15	100.0	20	100.0	95	100.0

The test for linear trend in the proportion of male/female deaths with increasing nutritional status was statistically significant ($p<0.025$)

of the possible twelve cells (four nutrition and three age groups) by the number of child months in each cell. Out of a total of 109 deaths in children 1-36 months of age covered by the anthropometric survey 73 (66 percent) qualified for inclusion. Because some deaths were obviously missing from the numerators as well as the denominators, the risk is probably underestimated.

Table 5.5 shows the estimated risk of death from the three age intervals and by nutritional category. Within each age interval the probability of death appears to decrease exponentially with every 10 percentage point increase in nutritional status. For children under 70 percent of weight for age the risk of death seems uniformly high over the different ages under consideration. For children between 70-79 percent, risks are higher at the earlier ages compared with 1-3 years. For over 80 percent weight for age risks are uniformly low. Table 5.5 by itself does not permit drawing any conclusion on long term risks of dying. But we can get a rough estimate by considering two hypothetical children at the extremes of the nutritional spectrum. If a child stays under 60 percent from 0-36 months and we assign it arbitrarily the average risk for that weight group for each age, its chances of survival to 36 months would by .77. If a child stays over 80 percent throughout the first 36 months and we assign it the average risk, its chances of survival would be .98.

When one compares this with the real overall death rates, it is clear the risk of death in each weight category has been underestimated, as mentioned above. Moreover assigning these hypothetical children the average risk at each age ignores the fact that long periods of undernutrition may carry excess risk or on the reverse rapid declines rather than stable undernutrition may carry excess risk. However, the estimated differential risk in different weight groups do give a first approximation of the real differentials.

Table 5.5

RISK OF DEATH AT VARIOUS LEVELS OF NUTRITION AND AGE INTERVALS

Age Interval (months)		Nutritional Status (% Harvard weight)			
		<60	60-69	70-79	80+
1 - 5.9	Deaths	3	5	9	7
	Child Months	205	527	1215	5276
	Risk*	.073	.047	.037	.007
6 - 11.9	Deaths	8	7	6	3
	Child Months	466	1386	2797	4720
	Risk	.103	.030	.013	.004
12 - 35.9	Deaths	4	12	4	4
	Child Months	1472	6646	13046	10479
	Risk	.065	.043	.007	.009

* Probability of death/child/age interval.

Birth weights were available on 99 children who died. Of these 38 (38 percent) had a birth weight below 2,500 grams. This compares with 207 children with a birth weight below 2,500 grams (24 percent) of a sample of 859 children from the general child population of the study villages ($p \leq .01$).

Practical Program Implications

The disease burden that children bear is staggering even in what has been considered the relatively "healthy environment" of the Punjab. At the time of this project, malaria had not yet reappeared, there were relatively few intestinal parasitic infections and levels of child and adult nutrition were among the best in India. Yet, our prevalence figures indicate that children were ill 11 percent of the time with respiratory tract infections, 6 percent of the time with diarrheal disease, 6 percent of the time with eye infections, and 4 percent of the time with fever. Prevalence tended to be highest when the child was nutritionally most vulnerable between 7 and 15 months of age during the period when breast feeding alone is insufficient. This congruence in timing between nutritional vulnerability and morbidity prevalence is made more serious because the two are causally related. In a subgroup of the study population we showed that several indices of immune capacity were significantly reduced in subclinical undernutrition[2]. We also showed that as mild an "infectious" illness as immunization with live agents caused a significant decrease in weight[3]. The findings from this study confirm and expand on earlier clinical analyses from these data on the reciprocal effects of undernutrition on morbidity and of morbidity on growth[4]. Finally, we have demonstrated that health care significantly contributed to reduction of illness prevalence through a decrease in disease duration,

a finding which is supported by detailed analysis of service inputs (Chapter 7).

The general effect of socioeconomic development is indicated by comparison of child mortality rates as recorded in the Khanna Study[5] thirty-five kilometers from Narangwal, between 1957-1959 with those from control villages of this project between 1970-1973. A dramatic fall in death rates was most evident in the 1-3 year age group (from 48 in the Khanna project to 19 per 1000 in Narangwal controls) and in the post-neonatal period (from 83 at Khanna to 53 per 1000 live births in Narangwal controls). The period from 1957-1959 to 1970-1973 spans the agricultural green revolution. During this time socioeconomic conditions in the average Punjabi home improved dramatically. The fall in child mortality during this time when accessibility and availability of government health services improved only slightly seems to reflect an improvement in the quality of life as reflected in better nutrition, sanitation, education, economic status, and private medical care.

Differences in mortality rates among the three caste groups also reflect socioeconomic influences on nutritional and health status. All caste groups appear to have benefited about equally from the various service inputs even though mortality rates of Ramdasia children were consistently higher than those of Jat children. Services were utilized approximately equally by all groups. In Chapter 3 it was shown that Ramdasia children, especially females, consistently had lower weight and height than other caste groups. They lived in more crowded and less sanitary houses, and had less access to private medical care facilities. Previously, we had demonstrated that among Ramdasias birth weights were 120 grams lower (2,700 grams) than Jat birth weights (2,820),

and that mean maternal height of Ramdasia mothers was 2.2 centimeters less than that of Jat mothers[6].

It was sobering to note that more than 60 percent of deaths between 0-5 years resulted from diarrheal disease and lower respiratory tract infections, conditions which are readily amenable to treatment. Gopalan had shown earlier[7] that these two conditions may account for more than 20 percent of preschool child mortality in India as a whole.

Of special importance from the detailed analysis of causes of death was the finding that 19 percent of perinatal deaths and 6 percent of deaths in older children were iatrogenic or related to inappropriate medical practices. These included pitocin injections during labor, forced feeding of newborns, under or overhydration and failure to provide tetanus immunization to mothers.

For rural Punjab we have identified the following "high risk" factors predisposing to child mortality in order of importance: (1) below two years of age, (2) prior low nutritional status, (3) low birth weight, (4) low caste, (5) female, (6) a history of previous sibling deaths in the family, and (7) higher than sixth birth order.

If health service resources are scarce, as they are in most developing countries, identification of risk factors and focussing care on those most at risk, in an intensive service program would seem to make more sense than providing "diluted" services to all preschoolers. Under the resource constraints of the Punjab, intensive MCH services might therefore be concentrated on children below two and especially those whose weight has dropped below seventy percent of the Harvard weight-for-age median.

Most dramatic was the sharp increase in the relative risk of death with every ten percentage point decline in weight-for-age below 80 percent of the

Harvard weight standard. These results indicate the importance of nutritional status in mediating other "high risk" factors.

Several of these risk factors which would normally be considered to be biologically determined were accentuated in their effects by social or cultural practices. Most apparent was the finding that mothers of children who dies below six months of age or who were severely malnourished at death had sought treatment later in the illness than when children were older or better nourished. The greater risk of dying of female children and their overall lower nutritional status was clearly associated with differential mother-care related to male preference.

Climate and seasonal change represents another external risk. Higher mortality occurred during the harvest season (April and May) when climatic conditions are especially severe and child care is left to older siblings because all adults are extremely busy. This seasonal difference in care resulted in sharp increases in malnutrition during a time when food should be amply available. We demonstrated that a practical solution to these problems was to set up day care centers during harvest as a base for focussed health education and care.

In all age groups, each of the service packages seemed to reduce mortality rates. One important differential finding that emerged was a beginning definition of the frequency of surveillance contacts needed to produce a change in mortality. In the four villages of the population project there was a sharp contrast between the consistently higher mortality experience during the first year of life and the dramatic reduction in 1 to 3 mortality. The child care services were similar in nature to those in the NUTHC villages

but the frequency of home visiting (once every two months) was only one-eighth of the frequency in NUTHC (once a week). This suggested that early detection of potentially serious conditions followed by ready treatment as a part of frequent home visiting was especially important in reducing infant deaths. On the other hand, ready availability and accessibility of primary care in the village clinic at the initiative of the parents, worked sufficiently well to reduce mortality in 1 to 3 year old children. This difference in the impact of intensive health surveillance between those below and above one year of age may reflect the distribution of age-specific causes of death (i.e., lower respiratory tract infection in the young, as compared with diarrhea and malnutrition in the older children). It may also be due to increased resistance of older children to infections or capability of mothers and family members to recognize and seek treatment for severe illness. It is probable that a weekly health check by a health worker would be more intensive than could be afforded in any but a research setting. However, mothers or lay (community) volunteers could easily be taught the essentials of health surveillance, such as recognition of the danger signs and symptoms of pneumonia or diarrhea as well as what to do if these signs were found. Had the nutrition study continued, greater utilization of lay personnel in surveillance for the "first-line" management of common child health problems would have been the next logical extension of our applied research program.

The impact on perinatal deaths in nutrition care villages was presumably because prenatal services included nutrition and health education and regular administration of iron and folic acid to mothers. In addition, food supplements were provided to "needy" mothers at their request or on the initiative

of the FHW. During the postneonatal period medical care, either with or without nutrition care, clearly was more important than nutrition care alone. This is not surprising; most child deaths in this age group result from conditions that require fast curative interventions, i.e., pneumonia, septicemia, gastroenteritis. While premature infants or those who become malnourished in the course of the first year undoubtedly run a higher mortality risk from these diseases the nutrition service components (supplementation and education) were less effective at this age than above one year of age. In addition, our services succeeded in prolonging breastfeeding so that most infants in this area were not fully weaned until well into the second year of life. In the second and third years of life, nutrition and medical care or their combination in both the nutrition and population project villages had significant impact on child deaths.

Summary

1. Morbidity reduction was manifested mainly in a shorter duration of average episodes of illness in villages receiving health care. Of the eight symptoms for which data were analyzed singificant reductions were recorded for mean duration of each episode of cough (reduction of three days), fever (reduction of one day), diarrhea (reduction of one day), and eye infections (reduction of one day).

2. An example of program synergism in which a combination of nutrition care and health care produced a greater effect than health care or nutrition

care alone was in eye infections where a further reduction of about one day was demonstrated.

3. As compared with mortality in the third year of life, death rates were twenty times higher in the first year, and three times higher in the second year of life.

4. Males had higher stillbirth and perinatal mortality rates. After the first week of life, female mortality was greater, with male to female mortality ratios of 0.9 for neonatal mortality, 0.7 for postneonatal mortality, and 0.6 for 1 to 3 year child mortality.

5. Causes of death from 1-7 days of age were ranked as follows: prematurity, intrauterine asphyxia, birth trauma, congenital anomalies, and tetanus neonatorum. Causes of death from eight days to five years of age had the following ranking: diarrhea with dehydration, lower respiratory tract infections, marasmus, prematurity, septicemia, tetanus neonatorum, accidents, and congenital malformations.

6. Program interventions had varied effects on mortality depending on age:

a. Nutrition care reduced perinatal mortality (stillbirths and 1 to 7 day mortality) by 40-50 percent, probably mainly as a result of prenatal supplementation with folic acid, iron and calories. Medical care (health education and tetanus toxoid to mothers) reduced perinatal mortality by about 20 percent.

b. Neonatal mortality was reduced by about 40 percent in all groups of villages where either nutrition care or medical care were provided.

c. Postneonatal mortality was reduced by half in health care villages but by only 7 percent in nutrition care villages. Since nutritional

inputs became effective mainly after six months of age, most of the reduction in mortality in nutrition villages would have been concentrated during the later months of the first year.

d. Infant mortality rates were reduced by about 40 percent in both groups of villages receiving medical care and by 25 percent in villages receiving nutrition care.

e. Mortality of 1-3 year old children was reduced by about 40 percent in all villages receiving services.

7. Primary health care delivered by FHW's provided an effective approach to the control of illnesses of children in Punjab villages. Not only did FHW's effectively care for about 90 percent of illnesses and appropriately refer the remaining 10 percent, but there are also reasons to think that the care they provided for infants was better than would have been provided by having an equivalent number of doctors available in health centers. The greatest impact on health status of children under one year of life seems to have been related to the frequency of contact through weekly morbidity surveillance and prompt treatment and doctors would be unlikely to do this kind of home visiting. These intensive contacts produced maximum impact on duration of episodes of infection and on infant mortality. There seemed to have been little impact on mortality under one year of age from the less intensive morbidity surveillance provided every two months in villages of the population project. If primary health care had been provided by doctors readily available within the village this would presumably have required parents to take intiative in seeking care and this did not happen at younger ages or when there was malnutrition.

For general coverage, it will be desirable to increase parent initiative. Greater impact on infant mortality would be achieved if sufficient attention were paid to parent education so that they could manage the surveillance activities themselves, but this will probably take long and persistent effort. A modification of this approach will probably be necessary if the population covered by an ANM were set at 5,000 as projected in present government plans. Surveillance would then have to be carried out by community health workers. By contrast, the 1 to 3 year child mortality dropped just as dramatically in villages which received surveillance visits every two months as in villages which received weekly home visits. Therefore, intensive surveillance might profitably be limited to children under 1 year of age, where it is most effective and needed.

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Chapter 6

EVOLUTION OF APPROPRIATE SERVICE MEASURES

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An important contribution of the Narangwal Nutrition Project was to develop a systematic procedure for monitoring key indices so as to encourage rapid feedback and prompt change of field procedures. As mentioned in Chapter 2, an evolutionary approach to defining service inputs was part of the design of the project. We decided that we would not try to maintain a fixed set of inputs during the whole time of the experiment since we really did not know at the beginning what methods would work best. If field experience showed that we could improve on a field procedure it would have been unethical to continue to use the original methods.

All the field methods evolved progressively from experience throughout the project. To illustrate this process this chapter presents findings from a particular period (1971 through 1973) when it was possible to delineate clearly a series of steps that had dramatic program effect. They are presented to encourage those who are working in demonstration projects or in routine services to use similar simple methods to improve their services.

The situational analysis described here resulted from a special study of causes of child death. Even though mortality had considerably improved

there were still high death rates from specific causes, particularly diarrhea, pneumonia and tetanus. Changes in service procedures subsequently led in one year to a 50 percent reduction in the death rate from diarrhea, and a 45 percent reduction in the death rate from pneumonia, despite the fact that severe weather conditions seemed to have increased the incidence of both conditions. In addition, adequate tetanus toxoid immunization of 87 percent of women in reproductive ages was achieved and neonatal tetanus was essentially eliminated in health care groups.

The simple system that was developed to monitor the effectiveness of project services and to provide rapid feedback included the following procedures*:

1. A simple method for rapidly reporting deaths of children under three in village homes.

2. A method to determine the most probable cause of death.

3. Bi-weekly meetings of supervisors and field staff at which reported deaths, changes in morbidity patterns, and other selected topics were discussed and service records reviewed. During this period the practice was started of holding these meetings in the village subcenters.

4. Revision of standing orders and other procedures based on the results of these discussions.

5. Retraining of the staff in regular, bi-weekly, in-service training sessions.

6. Maintaining high priority files for the follow-up of children at increased risk of illness or death because of anemia, TB, malnutrition, etc.

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* Described in greater detail in Chapter 2.

These procedures were independent of the more detailed research data which were also being collected and would take years to analyze. Of the three selected health problems, diarrhea and pneumonia improved dramatically in response to surveillance and early treatment, and neonatal tetanus improved because of immunization procedures.

Analysis of Causes of Death

In community based health care it is often difficult to get precise information on causes of death because deaths usually occur at home and frequently among those who have made least use of the services. Although a considerable improvement in child mortality had occurred, in 1971 a system was started to accelerate the reporting of deaths from the villages so that a project pediatrician could visit the family promptly to conduct a "verbal autopsy." In a high proportion of cases a cause of death could be ascribed with considerable confidence.

As shown in Chapter 5, diarrhea was responsible for 44 percent of under-three deaths, and penumonia for 22 percent. Neonatal tetanus caused 19 percent of deaths under 1 month of age[1]. It was apparent that the procedures for managing or preventing these conditions that were introduced at the start of the program were either no longer being adequately implemented or were not making the desired impact. Reemphasis of the importance of these conditions to the staff and revision of the procedures for managing these diseases were followed by intensive programs of in-service training and supervision as described in detail below.

Situational Analysis of Diarrhea and Pneumonia

A high priority item for discussion in the bi-weekly village staff

conferences was the high proportion of deaths due to diarrhea. The original treatment guidelines had presented diarrhea as an important disease problem, but had not singled it out as the most important cause of child death. Review of more than six months' individual case records followed by discussions with staff and village people revealed that oral fluid treatment was not well accepted by village mothers and was considered second rate care by FHW's for a complex set of reasons. In the local culture there was a traditional reluctance to give fluid to a child with diarrhea, partly because of the valid observation that giving fluid, especially milk, caused a prompt increase in diarrhea or conversely an effective way of stopping diarrhea was to produce dehydration. Most FHW's believed antibiotics and parenteral* fluids at the primary health center were superior forms of treatment because they fit the image that in-patient care is good quality care.

Criteria for differentiating between serious and minor diarrheal diseases were inadequate and failed to distinguish sufficiently the importance of the simplest home methods for maintaining hydration in the very large number of insignificant cases. The care recommended for children with clinical signs of severe dehydration seemed to deemphasize the importance of oral rehydration since standing orders stressed the importance of referring such children to a physician for parenteral fluid therapy. It was found that many children died at home of dehydration which developed after they had been seen by the family health worker because parents were unwilling or unable to go to the health center. Others died without ever being seen. Little progress was being made in increasing the use of oral fluid treatment in the home.

* Intravenous, subcutaneous or intra-peritoneal administration.

Pneumonia, the second most important cause of child death, seemed at first to be a simpler problem. Standing orders called for no treatment in the village for children with signs and symptoms of lower respiratory tract infection -- all were to be referred promptly for physician care. Criteria for recognizing serious cases of pneumonia with respiratory distress had been developed but were not being used effectively by the FHW. Most villages were four to ten kilometers from project headquarters, but two were more than 14 kilometers distant. A note requesting an emergency visit by a project physician usually was hand-carried to Narangwal by a family member riding a bicycle. Treatment delays of hours, occasionally days, were common.

Reevaluation of the management of these conditions was initiated as a result of discussions about the causes of mortality among the supervisory staff. Standing orders for both diarrhea and pneumonia were revised (a) to establish clear guidelines for differentiating between serious and minor illness; (b) to reinforce and reestablish procedures for regular follow-up of these potentially life threatening illnesses; and (c) to shift responsibility for treatment as much as possible to village level workers, since the emergency referral system imposed insuperable logistic problems for conditions that were both common and required a rapid response.

Subsequent discussions with village workers and mothers confirmed the practicality and acceptability of these decisions and led to many refinements and additions. For diarrhea, it became clear that the only feasible approach was to go even farther than first anticipated and rely on community participation by shifting responsibility for oral rehydration to the mothers. The volume of cases was so great that it was impractical

for village workers to care for every case. The incidence of diarrhea was sufficiently high so that most mothers had the opportunity to treat several episodes of diarrhea each year in their children under three years of age. Eighteen months after the revised procedures to train mothers to provide oral fluid therapy were implemented, workers reported that most mothers had already started treatment before the child was seen by project staff on weekly morbidity visits. The special parenteral rehydration unit that had been set up for project patients at the nearby center was no longer needed since the very few severe dehydration cases could be handled by regular health center staff.

Similarly, in the staff conferences, detailed discussions of the pneumonia problem led to a special training program to help FHW's diagnose pneumonia through recognizing a combination of clinical signs of fever and respiratory distress including drawing in of the spaces between the ribs and flaring of the nasal openings. They became expert in making appropriate clinical judgements and were remarkably conservative and accurate in their diagnoses. They were authorized to give a penicillin injection and then refer the patient to a project pediatrician.

Revision of standing orders for diarrhea and pneumonia involved changes in diagnostic criteria (signs and symptoms) and in the treatment. The final set of standing orders for both conditions resulted from several months of field trial and revision.

1. *Diagnostic Criteria for Categorizing the Severity of Diarrhea*

	Findings	*Grade*
History	Six or more stools/24 hours	+
	Vomiting	+
	Fever	+
	Blood and Mucus in stool	+
Special Character-istics	Less than 1 year of age	+
	Less than 70% of Harvard weight-for-age median	+
	consumption of less than 500 cc of sugar, salt and water mixture during 12 hours (only on revisit after 12 hours)	+
Physical Examination	Temperature (Rectal) 100°F or higher	+
	Signs of Dehydration	++
	Temperature (Rectal) 103°F or higher	++
	weight loss (detected at revisit)	++

2. *Categories of Treatment Procedures for Diarrhea*

a. Diarrhea in the absence of any of the above criteria:

Explain need for fluid replacement and preparation of "home diarrhea misture" (6 teaspoons of sugar and 1 level teaspoon of salt per liter of water) to mother. Mother to administer at least one liter of fluid per twenty-four hours and to continue regular caloric intake. Instruct mother to return to village clinic next day if diarrhea persists. Revisit child within one week.

b. If any of the "one-plus" criteria are present:

Prepare 1 liter of "home diarrhea mixture" and start giving it to child. When child is taking fluids show mother how to give it and how

to prepare more. Advise continuous fluid intake; two to three liters per twenty-four hour period. If child is on milk supplement, ask mother to stop milk for twenty-four hours but continue all other foods. If exclusively breast-fed, skip one feeding. Treat fever, blood or mucus in stool, if present, according to standing orders.

Revisit home within 12 hours

c. If any of the "two-plus" criteria are present:

Prepare "project diarrhea mixture" (from a diarrhea mixture concentrate prepared in the project pharmacy, which contained sodium and potassium chloride - no sodium bicarbonate; sugar from the home supply was added) Start giving it to child. Send message to physician for immediate consultation.

Remain with child giving fluids until physician arrives.

3. *Diagnostic Criteria and Treatment Procedures for Pneumonia or Lower Respiratory Tract Infection*

Presence of either of the following combinations was considered adquate reason for family health workers in the village to start penicillin treatment:

- cough and fever with temperature 102 F or higher (rectal)
- cough with labored respiration, i.e., flaring of the nasal openings, drawing in of the spaces between the ribs

Penicillin treatment began with an immediate injection of crystalline (rapidly acting) penicillin and benzathine (long acting) penicillin to get both immediate and long lasting effects (dose varied according to age of child), followed by:

- if no improvement in clinical signs within 4-6 hours - repeat crystalline penicillin injection and refer immediately
- if improvement: refer to next clinic visit of doctor

Training Program

A practical in-service training program for all health workers resident in study villages was instituted. Training over a three month period was conducted in the village by the physician and public health nurse in the course of their supervisory activities and at formal training sessions at the project headquarters at fortnightly intervals. At these sessions recognition, management and referral of patients with diarrheal disease and lower respiratory tract infection was explained and demonstrated and the newly revised standing orders were discussed. Recent case histories were reviewed with respect to management and outcome. Following this training period, a village conference was held in each group of our villages every two weeks. At these village conferences a rough estimate of the incidence of both conditions was made by having FHW's relate their clinical experience over the preceding two weeks. Service and research records were examined for compliance with standing orders and the practicality of these orders was discussed. Children currently under treatment were visited in their homes when a visit could serve an educational purpose (e.g., demonstration of signs of dehydration). Deaths among children in each group of four villages over the preceding two months were reviewed and analyzed for cause, events leading to death, treatment and avoidability. Discussion of problems observed and results eventually led to further modifications in the standing orders. For instance, a single injection of a mixture of benzathine

penicillin and crystalline penicillin replaced daily procaine (intermediate duration) penicillin when the resident health workers pointed out that mothers frequently did not return with their children for repeated injections.

In 1971 diarrheal disease accounted for 20 deaths, pneumonia for 10 deaths in eight-day to three year old children, giving a cause specific mortality rate of 14.1 per 1,000 child years of exposure for diarrhea and 7.1 per 1,000 for pneumonia. Over the next 17 months after implementation of the revised standing orders and up to the end of the project, 15 deaths from acute diarrheal disease and 8 deaths from lower respiratory tract infection occurred, giving diarrhea and pneumonia specific mortality rates of 7.3 and 3.9 respectively, per 1,000 child years of exposure - about one-half of the rates in 1971 (Figure 6.1). The difference in diarrhea and pneumonia deaths between the two time periods is statistically significant ($p < .02$). This decline in mortality had not resulted from a decrease in the incidence of the two conditions. If anything, incidence increased - both because of better diagnosis and because of particularly harsh weather conditions. Mortality from other causes had already dropped and did not change further between the two time periods; it was 10.6 in 1971 and 10.7 per 1,000 child years of exposure in 1972-73.

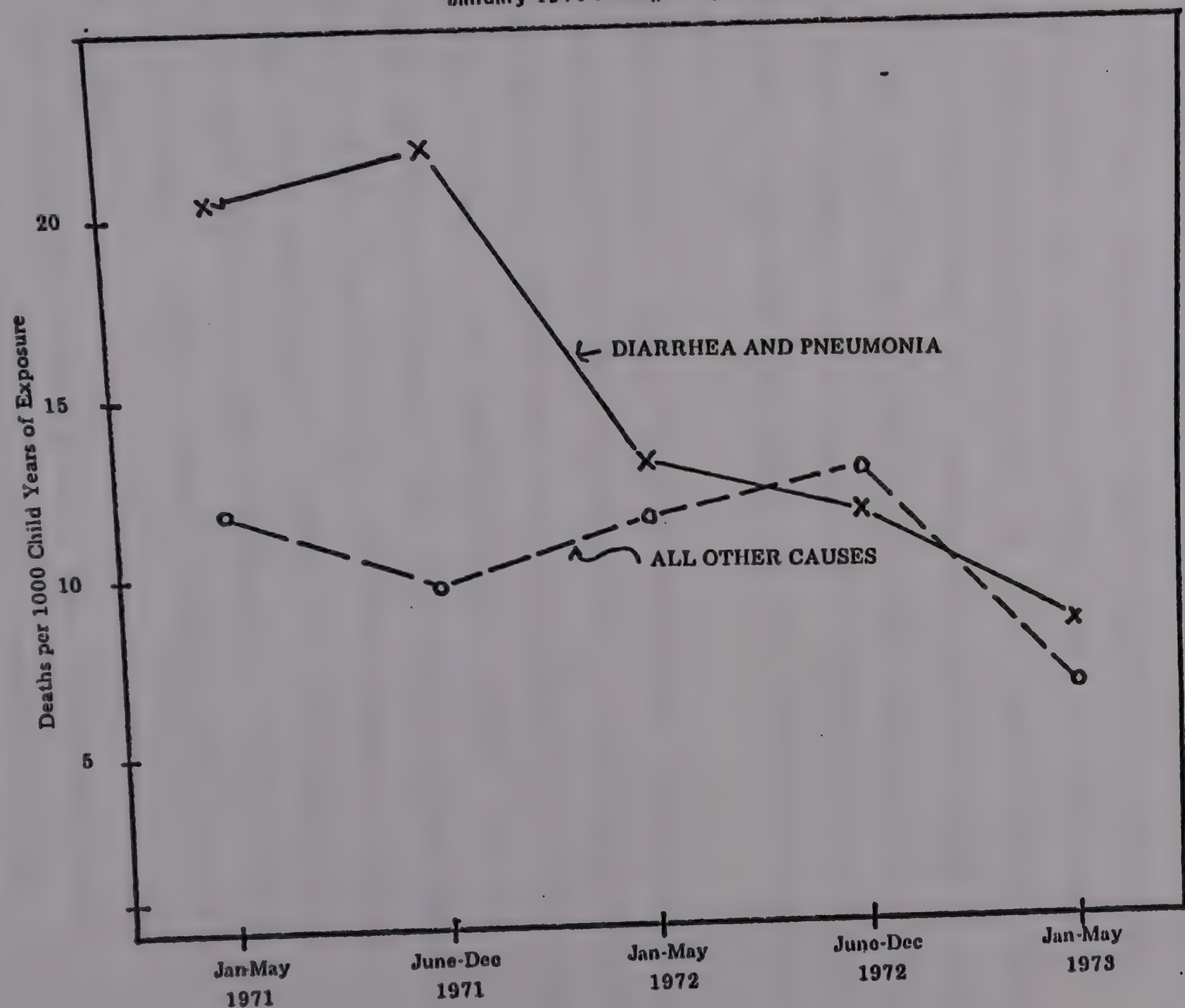
No allergic reactions, abcesses or other complications from penicillin injections were observed in the more than 200 children treated for pneumonia by FHW's.

Neonatal Tetanus

In contrast to diarrhea and pneumonia, neonatal tetanus is a disease in which a program of surveillance and treatment would be essentially

Figure 6.1

NUMBER OF DEATHS PER 1000 CHILD YEARS OF EXPOSURE FROM
DIARRHEA, PNEUMONIA AND ALL OTHER CAUSES
IN EIGHT–DAY TO THREE–YEAR OLD RURAL PUNJAB CHILDREN
January 1971 through May 1973



meaningless, since treatment is extremely expensive and seldom effective. On the other hand, there are two effective approaches to prevention which seemed worth applying to the total popualtion because the disease was so common in the Punjab (fourth cause of death overall in the Khanna Study[3] and sixth cause of death among children in our study). One method was to educate and work with the dais (indigenous midwives) to improve the quality of care of the umbilical stump after the baby was born. This was a major emphasis in villages where the FHW/dai relationship was good. Although a great effort was made to get total coverage with prenatal care, the training of the dais depended on their willingness to cooperate.The second approach was to immunize mothers so that antibodies would be transmitted to the fetus during pregnancy. This approach was incorporated into routine antenatal care from the beginning of the project.

Following a review of tetanus deaths by project staff, two modifications in the tetanus immunization program were suggested: (1) to immunize systematically all women in the reproductive age group irrespective of their current fertility status instead of only immunizing antenatal women; and (2) to use a tetanus toxoid vaccine requiring fewer injections to achieve immunity.

A field study which has been reported in detail elsewhere was designed to test these program modifications[4]. Fortunately a new commercial vaccine had become available featuring a higher concentration of calcium phosphate-absorbed toxoid (IPAD-T , Institute Pasteur, Garches, France) than in the standard vaccine.

In the first part of the field study a sample of 159 women between 15 and 44 years of age were randomly given either standard tetanus toxoid or

IPAD-T and followed with serial tests of antibody levels in their blood. Results indicate that a single injection with IPAD-T raised the levels of circulating antibodies by approximately the same amount as three injections of standard tetanus toxoid. We are not aware of any deaths from neonatal tetanus in infants whose mothers had completed a full course of three injections with standard toxoid. We therefore assume that one injection of IPAD-T would be equally effective.

In the second part of the study, out of 1820 women, we were able to immunize 1583 (87 percent) with one injection of IPAD-T in the course of a single routinely scheduled immunization round and saw no further cases of tetanus in these experimental groups.

Conclusions

The procedure developed to manage diarrhea, pneumonia and neonatal tetanus in this project can be adapted to the many villages of the world where these problems are also the principal cause of death. Introducing and implementing new standing orders does not require setting up a research project but could be done in any service with systematic mechanisms for reviewing field procedures. In our case complete reporting of mortality and morbidity made it possible to document their effectiveness but detailed mortality and morbidity rates are not necessary for defining local problems and setting up active in-service training and supervisory activities. In fact, precise data did not become available until long after the special review process was completed.

Other health service programs could focus similarly on reducing child

deaths by establishing a simple monitoring system for deaths, reviewing their importance and vulnerability to intervention under local conditions and then developing or modifying field services. Other relevant information such as relative disease incidence, adequacy of response to treatment and unusual complications can be derived from service records or can be elicited impressionistically during discussions with staff.

The principle of establishing ongoing evaluation of service activities with immediate feedback into in-service training is based on the reality that standing orders, supervisory procedures and training programs prepared at the start of a new program or developed at any point along the way cannot be expected to be either completely relevant or effective. Identification and correction of problems requires both continuing evaluation of program effectiveness and a procedure to communicate this information to supervisors, village workers and the community. Involvement of all levels of workers in analysis of problems was an essential element in the success of this program. The system of review was a learning process for all members of the staff and ultimately for the community. The importance of community involvement was demonstrated most effectively in teaching mothers to take responsibility for starting oral rehydration immediately at the onset of significant diarrhea. For primary care workers in-service training of this sort is probably more important than their original training. Frequent conferences based on service records, especially if conducted at the place of service delivery, are an important element in providing the kind of supportive supervision that tangibly improves the quality of peripheral health services.

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CHAPTER 7

MEASUREMENT OF SERVICES AND COSTS

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As the services of the Narangwal nutrition project were being developed it was clear that detailed information about service inputs and activities would greatly improve our understanding of the dynamics, costs and effectiveness of the interventions used to influence mortality, morbidity, and growth and development. There were obvious variations in workloads of family health workers because of differences in the service packages in the various experimental groups of villages. Quantitative measurements of service inputs were therefore included as an integral part of the data gathering. Selection of measurement methods relied heavily on experience gained in the functional analysis of government services conducted at Narangwal and other sites[1]. This long term research effort developed a systematic approach to relating health needs to health services and community resources.

Justification for functional analysis studies of interventions in the nutrition project was based on the following anticipated benefits:

1. A fundamental purpose of the research was to evolve the best packages for each experimental group rather than rigidly holding to predetermined patterns of work. During the first two years of fieldwork this effort was based on empirical observations and intuitive assessment of service activities. To permit further refinement of services we needed

measurement methods that were more precise and immediately relevant for rapid feedback to improve services.

2. By documenting the activities, efforts and costs required in the delivery of services, it would be possible to plan practical adaptation of the Narangwal service pattern to other situations using quantitative estimates of required inputs.

3. Input data were related to specific functional components of services which would permit placing "price tags" on each service component so that administrators and health planners who were designing new nutrition and child health programs could use the Narangwal experience as a guide in estimating costs.

4. At the Narangwal Rural Health Research Center the development of service activities was intimately intertwined with multiple research, training, and demonstration activities. For example, surveillance activities were especially important not only for gathering some of our most significant research data but also were a key element in maintaining effective services. Detailed measurements of input and activity data were therefore required to separate out most of the effort and costs related to actual services from research and training activities. This provided a more rational basis for recommendations about service packages which would be relevant in purely service settings. Rather than subtracting costs in control villages from service village costs, we tried to estimate more accurately the proportion of each activity that could be classified as research. A systematic review was conducted by the health professionals involved in the field work on an

item by item basis and the proportion that was primarily research was estimated by consensus. Using this procedure, some of the costs in control villages were allocated to service because they would have been important in surveillance, early detection and treatment under normal service conditions.

5. Finally, these data provided variables that could be used for input-output analyses such as cost/effectiveness calculations and regression equations designed to establish the relative cost or importance of specific service components in producing desired outcomes.

Methods

To generate the service input information presented in this chapter, data were collected in all project villages by a separate evaluation team. Field methods from our functional analysis research[2] were adapted as follows:

1. Work sampling produced detailed information on the time spent by project staff in providing specific services in study villages. Observers followed all service staff on at least 24 different days sampled throughout one full year of the project (1971), recording the functions and activities performed at every two-minute interval during the observation day.

2. Information was abstracted from individual service records for all years of the project (1969-1973). These data consisted of a description and count of all project services that were received by each study child.

3. Information on feeding center utilization by children in the study villages was obtained from three sources: (a) counts of all visits to the feeding centers by any child receiving supplements; (b) detailed records of the supplementation received by children under three years of age who

were below 70 percent of the Harvard standard weight median or who had been below that standard during the preceeding two months; and (c) records of food supplied to the feeding centers which were used as a means to verify the visit counts.

4. A sample household survey was carried out in all study villages during the final year of the project (1973). Two hundred households were randomly selected in each experimental group yielding approximately a 40 percent sample of all households. This survey provided an estimate of the use and cost of services other than those available within the project (e.g., use of private practitioners or government services).

5. Detailed accounts were maintained of all costs related to the provision of services for each year of the project. These costs were allocated to specific activities and services mainly according to work sampling information using methods worked out in the previous functional analysis project[3].

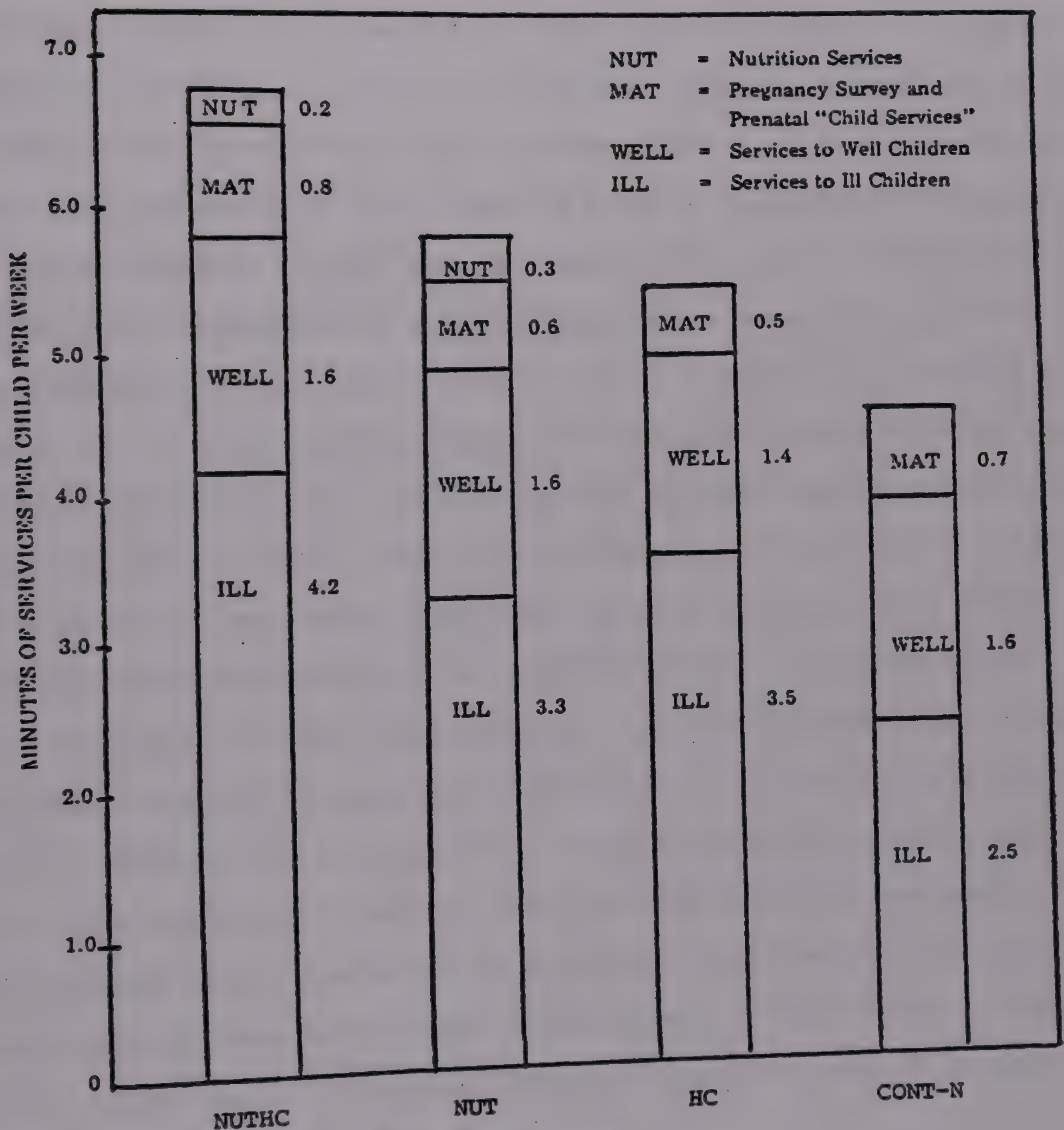
Results

Time Inputs

The average amount of direct service time spent by project staff with each child under three years of age is summarized in Figure 7.1. This varied from an average of about seven minutes per child per week in the villages receiving nutritional supplementation and health care services (NUTHC), to less than five minutes per child in control villages (CONT-N). The latter consisted primarily of surveillance visits as part of longitudinal surveys. Contacts with ill children (identification of ill children in the

Figure 7.1

Average Time per week Spent per Child Under Three Providing Direct Services by Staff* in All Experimental Groups (1971)



*Excluding village attandant

home, treatment in the home when appropriate, and clinic visits) averaged 4.2 minutes per child per week in NUTHC villages; 3.3 minutes in villages receiving only nutritional supplementation (NUT); 3.5 minutes in villages receiving only health care; and 2.5 minutes in control villages. These time differences probably are related to a) variations in numbers of ill children identified per visit, b) provision of specific treatments in NUTHC and HC in contrast to symptomatic medications in NUT and CONT-N, c) time available per home visit (especially in NUTHC where the ratio of children per family health worker was purposely adjusted down to compensate for their combined health and nutrition responsibility) and d) rapport of the worker with the family. All these factors would tend to make time spent in NUTHC on ill children greater than in the two single service groups and definitively more than in the controls. It should be recalled that in NUT and control villages detailed morbidity data collection was carried out just as in HC villages and family health workers had a few purely symptomatic drugs that they could use to maintain rapport. If a life threatening condition was identified in NUT and control villages and a "technical knockout" (TKO) declared, full-scale treatment efforts were initiated. When NUT villages are compared with HC villages the time spent with ill children over and above the time spent for surveillance was almost identical which seemed to indicate that providing definitive treatment to sick children in HC villages did not differ very much from the time required to give them symptomatic treatment in NUT villages. (This finding is supported by the similar number of treatment contacts in these two sets of villages identified in the service record analysis.)

Almost no variation was observed in the time spent per well child in the following activities: morbidity survey and monitoring weight in all villages, giving immunizations, health and nutrition education, and "pre-

natal child care" in the apporpriate service villages. Time with well children averaged 1.6 minutes per child per week in all villages except for HC where it was 1.4 minutes. Visits to eligible women (married and 15-49 years of age) every two months to identify pregnancies early and institute simple antenatal care ("prenatal child care"), required only from 0.5 to 0.8 minutes per week per child (or 0.3 to 0.5 minutes per week per eligible woman).

Over 95 percent of the staff time input was the work of the family health worker assigned to each village. The one exception to this was in nutrition supplement villages where village women were employed as "feeding center attendants" to provide most of the direct services to children receiving food supplements. As seen in Figure 7.1, nutrition contact by staff other than the village attendants averaged only 0.2 to 0.3 minutes per week per child under three.

If we assume that the time in the control group was mainly for surveillance activities and that these same activities were also carried out in the experimental groups, we can conclude that surveillance took over two-thirds of the service time per child. The justification is that surveillance greatly increased the efficiency of services actually provided and ensured that they reached those in most need.

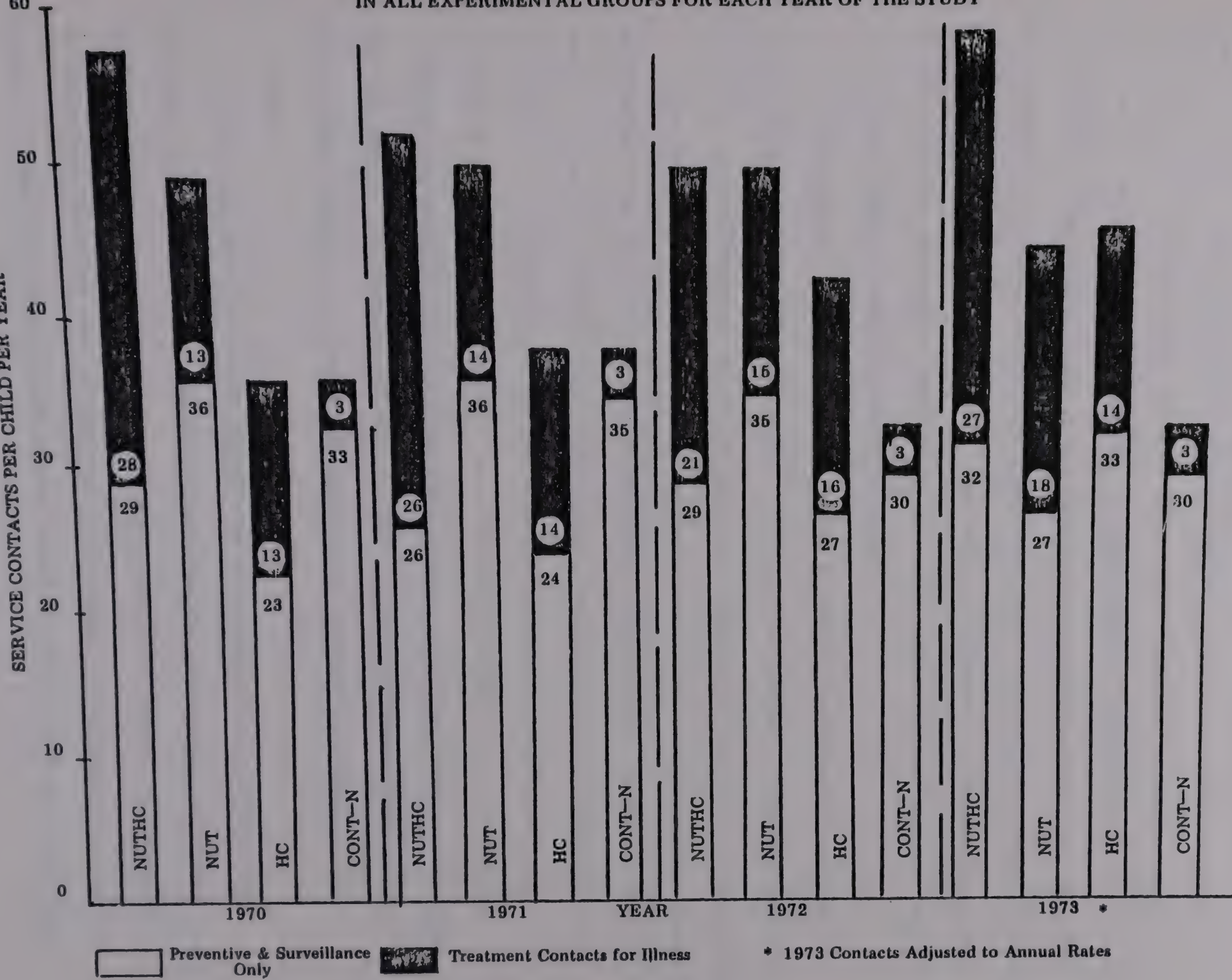
Finally, since the average times include all children under three whether they actually received services or not, these figures should not be interpreted to reflect the real time inputs provided any individual child receiving care.

Service Contacts

Figure 7.2 summarizes the average annual number of services received by each child in the various experimental groups. The variation between

Figure 7.2

AVERAGE SERVICE CONTACTS PER YEAR PER CHILD UNDER THREE
IN ALL EXPERIMENTAL GROUPS FOR EACH YEAR OF THE STUDY



years was not as great as the differences between experimental groups. Theoretically, each child should have received at least one contact per week according to the study design. This target level of contacts, however, was reached only in NUTHC villages. In this group of villages over 90 percent of children under three years of age received at least one visit for curative or preventive services during any given year, with the average number of contacts being between 50 to 60 per child. The control villages consistently had the fewest contacts per child, reflecting the difficulties of maintaining rapport in villages where no services were provided.

No significant differences were noted in use of services by caste or other socioeconomic characteristics. In fact, the project initiated services overcame any differences in use of services existing at the start of the project.

The majority of contacts involved only surveillance or preventive services and ranged from 23 to 36 per child per year. Contacts for treatment of illnesses (alone or combined with surveillance) were minimal and predominantly symptomatic in control villages but averaged between 21 to 28 per year per child in the NUTHC villages. As with time allocated to ill children, treatment contacts in NUT villages were limited to minimal symptomatic care, but because of the special efforts of FHW's in NUT villages their visits were almost identical in number to definitive treatment contacts in HC villages.

In NUT and NUTHC villages nutritional supplementation was provided systematically to children who were identified by anthropometric surveillance as being underweight or faltering in their growth and after 1970 to other children who chose to come to the feeding centers. By dividing the annual number of supplemental feedings by the number of children from 6 months to

3 years of age (the age group receiving almost all of the supplements) we obtained the average annual number of feedings per child, which was 255 in NUTHC villages and 370 in NUT villages. This is about 35 percent and 50 percent of the potential feedings of 730 per year if all children had attended the feeding centers twice every day during the study. (Since some pregnant women and children over three also received supplemental feedings the actual average feedings per child under three years would be slightly lower.) Although a special effort was made to maintain regular attendance by those who were below 70 percent of the Harvard weight-for-age median, actual attendance figures for children between 1 and 3 years of age and below 70 percent of the Harvard weight-for-age standard showed that they received about 40 percent of potentially available feeding. This demonstrates the difficulty of maintaining regular attendance among malnourished children in a village setting but also that partial services can achieve significant nutritional impact.

Use of Other Services

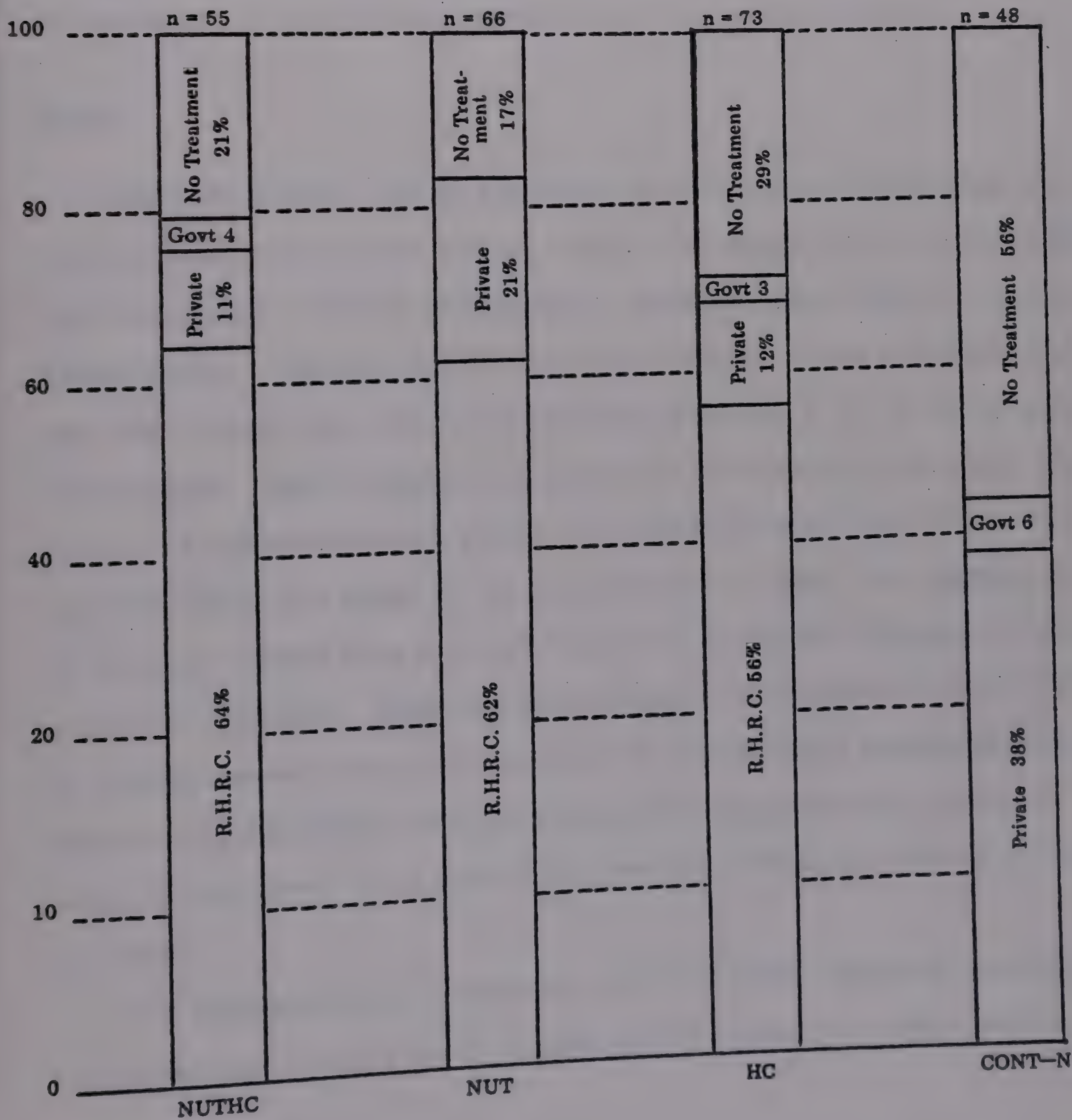
Extensive use of private practitioners, both qualified and unqualified was documented by previous surveys in the study area[4]. As seen in Figure 7.3, the ill children in the control villages who received treatment usually were seen by such practitioners. In the experimental groups of villages services provided by project personnel partially replaced other sources of care. However the most obvious impact was to reduce the number of ill children who went untreated or were treated at home from about 60 percent to 20 percent. In NUTHC and HC villages private practitioner consultations were reduced to about half of the rate in NUT villages where only symptomatic

Figure 7.3

PERCENTAGE OF ILL CHILDREN UNDER THREE RECEIVING TREATMENT BY SOURCE OF CARE — SAMPLE SURVEY IN ALL EXPERIMENTAL GROUPS. 1973

Key:

No Treatment	=	Illness not treated during two week recall period
Government	=	Illness treated in government or other facility
Private	=	Illness treated by private practitioner (qualified or unqualified, traditional or allopath)
R.H.R.C.	=	Illness treated by Narangwal Staff



care was given and to about one-third of the rate in control villages. The remarkably high rate of clinical contacts with Narangwal staff in NUT villages was due to exceptionally good interpersonal relationships with FHW's even though only symptomatic treatment was being given. Government services, such as those provided by primary health centers, accounted for only a small part of the services used, even in the control villages which were closer to government primary health centers than other study villages.

Costs

The cost analysis was as inclusive as possible when developing the line item components of project service costs. For example, all donated drugs, food, buildings, and land were given an estimated value based on current market prices. Capital expenditures for buildings, large and small equipment and vehicles were amortized at annual rates of 2, 5, 10 and 10 percent respectively. These various cost components that made up the annual costs in each of the experimental groups are listed in Table 7.1. As can be seen from the table, the share of the costs related to labor (the service component of salaries) ranged from a low of 39 percent in the NUT villages to 64 percent in control villages. NUTHC and HC villages were intermediate with 45 and 58 percent respectively. If the costs of the nutrition supplementation program were subtracted from the NUTHC costs the proportion related to salaries in the latter group would be 59 percent, almost the same as in the HC villages.

The supplementation program was one of the most expensive components of the services, making up 45 percent and 57 percent of total costs in NUTHC

Table 7.1

Percent Distribution of Cost Categories in Each Experimental Group Based on Average Annual Costs for 1970-73

Cost Categories	Experimental Group			
	NUTHC	NUT	HC	CONT-N
Buildings (2%)*	1.2	2.3	2.8	4.4
Maintenance	1.4	2.9	3.4	5.4
Equipment (5 or 10%)*	1.4	1.1	1.9	2.2
Supplies	6.7	6.3	7.7	7.2
Vehicles (10%)*	1.0	1.4	2.5	2.0
Vehicle Running and Maintenance	5.1	7.1	12.4	10.2
Food	25.8	35.2	-	-
Drugs	10.5	3.2	9.4	3.5
Referrals	1.8	1.3	2.3	0.1
Salaries	45.1	39.2	57.6	65.0
TOTAL	100.0	100.0	100.0	100.0

* Capital expenditures amortized as indicated to provide annual costs.

and NUT respectively. In both of these experimental groups, expenditure on food alone was about 60 percent of the supplementation program expenditures. The amortized capital costs were only 4 to 9 percent of the total costs in any of the groups. Thus other costs for materials consumed annually (supplies, food, drugs, etc.) were about 56 percent in NUT, 51 percent in NUTHC, 35 percent in HC, and 26 percent in CONT-N.

Drug costs are of considerable importance in planning primary health care programs. In the two experimental groups with definitive health care services the proportion of expenditure for drugs was 9.4 percent in HC and 10.5 in NUTHC. Finally, transportation costs ranged from about 6 percent in the NUTHC villages to nearly 15 percent in the HC villages. When compared to the distribution of expenditures in government health centers the major difference is that expenditures other than salaries are more limited in government services, with salaries consuming about 75 percent of all funds available[5].

Total costs for project services (excluding research and development costs) ranged from an average of 176 rupees ($23)* per child per year in NUT villages, to 58 rupees ($7.5) in the control villages (Figure 7.4). Spread over the total village population the costs to provide combined NUTHC services for children under three would be about 14 rupees ($1.8) per capita (total population) per year. As with the time data, the control village costs could be considered the costs of surveillance, symptomatic treatment to maintain rapport and treatment of children identified as "technical knock-outs."

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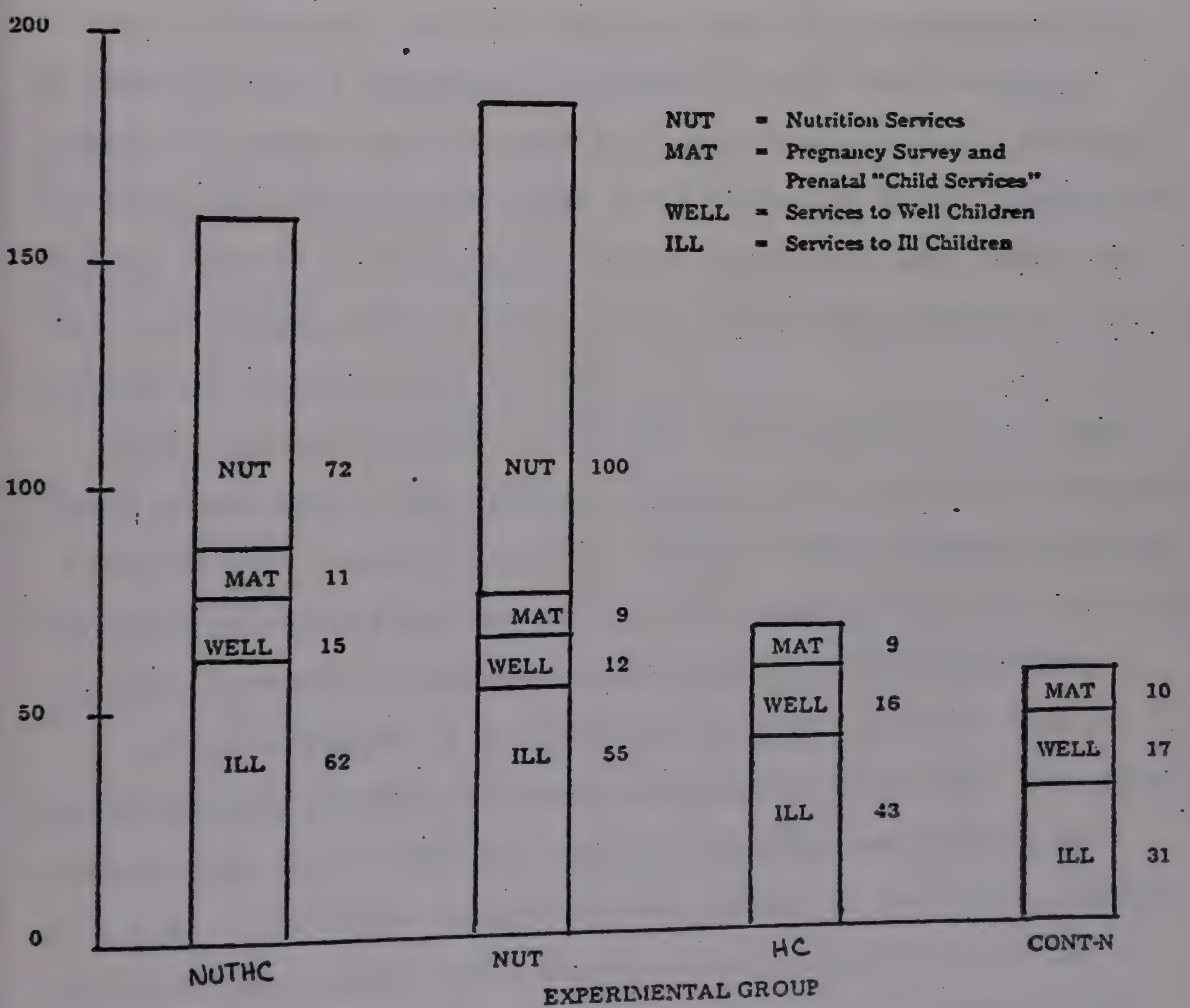
* Rs. 1 = $0.13

Figure 7.4

AVERAGE ANNUAL COST PER CHILD UNDER THREE

FOR SERVICES IN EACH EXPERIMENTAL GROUP

1970—1973 IN RUPEES



If the nutrition project services were replicated as part of a government program in India, actual total costs per child should not have been as high as those incurred at Narangwal because of differences in fringe benefits to workers, volume purchase of supplies and donations of food. It was estimated that costs under a statewide government program could be reduced by as much as 50 percent. Obviously the efficiency of the program might also be reduced in such a widespread replication. In any event a statewide program with similar services would still come to over 75 rupees per child per year. The equivalent per capita (total population) level of expenditure would be about Rs 7 ($1) per year. This is about three times higher than that in an average primary health center in Punjab which spent about 2 to 3 rupees per capita per year in 1969[6].

This comparison, however, is not valid as it assumes that the primary health centers were in fact providing services to the total target population of about 85,000. Actually only 10 to 20 percent of the children under three had access to curative services and the very limited maternal and child health activities provided by the primary health centers and their subcenters.

A better comparison of costs would be to use the costs per unit of service actually provided to a child. At Narangwal total costs per contact averaged about Rs 1.40 with the cost of an ill child contact being about Rs 2.50 to 3.70 (the few emergency illness contacts in the control villages were three times higher), and a well-child contact was Rs 0.35 to 0.60 (Table 7.2). These compare quite favorably to costs at a primary health center of Rs 1.50 per patient visit and Rs 0.80 for an MCH contact[7]. The

Table 7.2

AVERAGE COST PER SERVICE CONTACT OR FEEDING FOR CHILDREN
UNDER THREE IN EACH EXPERIMENTAL GROUP
1970-1973 - IN RUPEES

Type of Service Contact	Experimental Group			
	NUTHC	NUT	HC	CONT-N
Ill Child	2.48	3.67	3.07	10.33
Well Child	0.52	0.35	0.59	0.53
All Contacts	1.43	1.37	1.44	1.37
Nutrition Supplement *	0.33	0.32	—	—

* Cost per attendance at the feeding center

observed difference in per capita cost, therefore, is due to almost total coverage of the target population and the high service utilization rates of the Narangwal nutrition project as compared with primary health center populations. Service utilization in our study population was very high not only because of ready accessibility to primary care within each village, but also because of active health surveillance by family health workers. Our experience suggests that a relatively intense concentration of resources and effort may be required to produce any impact on child health and that the current dilution of effort in government services is probably below the threshhold level where they can be expected to have any significant effect.

Comparison of Narangwal costs with total health care expenditures in the private and government sectors produced an entirely different picture from comparison with government expenditures alone. As will be recalled, nutrition project services replaced some but not all of the existing private services (Figure 7.3). Table 7.3, therefore, summarizes the total expenditures on health care in the NUTHC villages and the control villages of the nutrition and population projects based on data from the project cost analysis, estimates of out-of-pocket expenditures from the sample household survey, and costs of government health care as determined in the functional analysis study[8]. Services in the table are divided into curative, nutrition and other (preventive, surveillance, maternal care, etc.). Data from the nutrition control villages do not include the cost of surveillance activities and emergency care, since these extra inputs were not provided in the population project controls. As can be seen the project provided some care to children over 3 years and to women in the child bearing age, but the majority of program costs were related

Table 7.3

COMPARISON OF TOTAL PER CAPITA HEALTH CARE EXPENDITURES IN NUTHC AND CONTROL VILLAGES - 1972-1973

Sources and Types of Services	Expenditures in Rupees			
	NUTHC Villages		Control Villages	
	Children Under 3 Yrs	Others	Children Under 3 Yrs	Others
Nutrition Project Serv.				
Curative	5.4	2.5*	-	-
Other	1.3	1.0	-	-
Nutrition	6.5	-	-	-
Private Practitioners Services:				
Curative	0.7	12.8	2.0	12.9
Other	-	2.4	-	2.4
Government & Non-Profit Services:				
Curative	0.3	0.5	0.4	5.1
Other	0.1	0.7	0.1	1.7
All Sources				
Curative	6.4	15.8	2.4	18.0
Other	1.4	4.1	0.1	4.1
Subtotal	7.8	19.9	2.5	22.1
Nutrition	6.5	-	-	-
Total (Rs)	14.3	19.9	2.5	22.1
Total ($)	1.9	2.7	0.3	2.9

Note: Sources of data included the project cost analysis, out-of-pocket expenditures and use of different services determined during the sample household survey, and costs of government services determined in the functional analysis study[8]. The control villages in this table are from both the nutrition project and the parallel population project. Costs associated with surveillance and treatment of emergencies in the nutrition project control villages have been excluded. The latter averaged about Rs 5500 per 1000 population in those villages.

* Costs of services provided to children over 3 years of age and women in the child bearing age.

to children under 3 years. Expenditures for care of children under 3 in control villages by private practitioners was Rs 2 per capita (total population), a figure three times greater than in NUTHC (Rs 0.7); but for other individuals such expenditures for private care were almost identical in NUTHC and CONT-N villages (about Rs 13 per capita). The proximity of government health centers to the control villages explains the much higher level of expenditures for these services in control villages, balancing somewhat the project costs for older children and women in the NUTHC villages.

The introduction of child care services (excluding nutrition supplementation) increased total expenditures on health care in NUTHC villages only about 12 percent when compared with the control villages (Rs 27.7 per capita versus Rs 24.6 per capita respectively. See Table 7.3) Curative service expenditures were only 9 percent more than in control villages, but the emphasis on prevention in our program is indicated by the finding that expenditures on other types of services were 29 percent greater than in control villages. It is significant overall that the combined child care and nutrition programs would increase all current expenditures on health at the village level in Punjab by only about 40 percent. This conclusion is quite different from the much larger discrepancy when comparisons were made only with government expenditures. Thus, in terms of the total economy of Punjab, the types of health programs introduced by the Narangwal project were within a realistic expansion of expenditures if government and community resources could be combined.

Effects of Services on Health Indicators

To sharpen the comparison of the impact of the various service packages, Pearson's product-moment correlations were carried out to measure associations

between the number of service contacts provided in experimental villages and mortality rates and mean morbidity duration of specific symptom complexes. For example, the total number of service contacts provided to children under one year of age in each experimental group of villages in each year was correlated with the experimental groups' infant mortality rates (IMR) for these years. Since the analysis was carried out with aggregate data from each experimental group the sample size was small. The following results must therefore be viewed only as indicative of the probable impact of the service packages.

Infant mortality rates were negatively correlated with the total volume of service contacts provided children under one year (curative and preventive combined) ($r = -.367$, $p \sim .05$, $n = 20$)*. In those experimental groups and years with greater service inputs there were fewer infant deaths. If the final year (1973) observations in the control villages are excluded from the analysis (because services and surveillance were terminated in one of the villages at the end of 1972) the association between services and the IMR was even more significant ($r = -.561$, $p < .01$, $n = 19$). There was also a strong negative correlation between the number of "prenatal child care" contacts during a given year and the perinatal death rates in the following year ($r = -.709$, $p < .005$, $n = 12$). Service contacts with children over one were, however, not well correlated with mortality rates of children in that age group. These findings generally support the program effects noted in Chapter 5, with infant mortality rates being lowest in health care groups of villages (NUTHC and HC). Perinatal death rates were also lower in all experimental groups as compared with controls.

* n = in this and subsequent findings indicates the number of pairs of variables available for that correlation. Each pair represents data from a given experimental group in a given year.

The mean duration of specific morbidity conditions was found to be correlated negatively with the frequency of service contacts for treatment. For example, mean duration of diarrhea in children under one showed a coefficient of -.706 ($p < .005$, $n = 16$) when correlated with treatment contacts in that age group. A similar analysis among children over one showed a correlation coefficient of -.517 ($p < .05$, $n = 15$) when the final year in the control villages was excluded. The average duration of several other symptoms including cough, vomiting, eye and skin complaints, also showed significant negative correlations with the volume of treatment contacts.

The only complaint which showed a significant negative correlation with the number of contacts for surveillance and preventive services was lower respiratory infection (pneumonia) in children under one ($r = -.513$, $p < .05$, $n = 14$). This supports the importance of early identification and treatment of pneumonia in infants through frequent surveillance as described in Chapter 6.

The effect of nutritional status on mortality was well documented in Chapter 5 and its impact on morbidity has been demonstrated in an earlier analysis[9]. We therefore attempted to link nutritional services measured by feeding center attendance to mortality and morbidity levels by correlating the number of supplementary feedings provided each year in the nutrition care villages (NUTHC and NUT) with mortality rates and mean duration of specific morbidity conditions. No associations were noted between these variables for children under one. The only significant correlations were between the mortality and morbidity of children over one year and the number of feedings in the _following_ year (r ranged from +0.8 to +0.9, all significant at $p < .005$). This highly positive correlation probably indicated the responsiveness of the

feeding programs to the fact that more children were malnourished following episodes of high morbidity. No other association between the number of feedings and morbidity or mortality measures was noted except for a weak, but consistent, negative correlation between feedings in one year and mortality rates in children over one year in the following year. The number of units in the analysis were too few to reach statistical significance, but the direction of the findings supports the previously identified reduction in deaths of children over one year in the nutritional care villages.

Cost/Effectiveness

By relating the costs of service programs in each experimental group to differences between outcomes measures in each experimental group and the control group it was possible to obtain specific cost/effectiveness ratios. Calculations of this type, however, are not straightforward. For example, the Narangwal services had a number of objectives including decreasing mortality, reducing morbidity, and improving growth and psychomotor development. All of these objectives are interrelated. Rarely does an intervention have an impact on only a single measure of effectiveness. This makes it difficult to allocate specific portions of costs to particular measures of effectiveness. Because nutrition contributes to both improved physical growth and psychomotor development, it seemed very arbitrary to assign some of the nutrition cost to growth and some to psychomotor development. If all nutrition costs were attributed to each benefit this would result in double counting of nutrition costs, but we could find no other way of allocating these costs. However, it was possible to separate out the costs related to reduction of mortality

and morbidity by allocating a proportion of nutrition and health care costs to prevention of deaths according to age-specific mortality rates. The balance of health care costs were attributed to morbidity reduction and the balance of nutrition costs to improvement of physical growth and psychomotor development.

Table 7.4 shows the comparison of the impact of the different service packages on indices of effectiveness. Health care services alone (HC) reduced infant and 1-3 year mortality most effectively. Nutrition alone (NUT) was most effective in reducing perinatal mortality (by including nutritional supplementation for pregnant women), in reducing 1-3 year mortality and increasing 0-3 year growth. As the best approximation of synergism between programs, combined nutrition and health care (NUTHC) in most cases was close to the performance of whichever of the more limited service packages that excelled so that overall it showed the maximum combined effect. It was best in its own right for reduction of morbidity in 0-3 year olds and improving psychomotor development.

Table 7.5 combines the effectiveness data with the costs allocated to the various measures as indicated above. Cost/effectiveness ratios are shown assigning an index of 1 to the most cost/effective packages for a particular impact. The dollar costs are given in brackets. The relative differences in the indices are likely to hold true in similar ecological settings, but the actual costs would, of course, vary with salary levels and prices. We also strongly suspect that in areas with food deficits and more severe malnutrition the cost/effectiveness of nutrition interventions, particulary those combined with health care, might be even more favorable.

Table 7.4

COMPARISON OF THE IMPACT OF DIFFERENT EXPERIMENTAL GROUPS ON SPECIFIC INDICES OF EFFECTIVENESS

	Perinatal Mortality	1 Year Mortality	1-3 Years Mortality	0-3 Years Morbidity	0-3 Years Growth	0-3 Years Psychomotor Scores
Maximum Effect: Actual *	Decrease of 43.3 deaths per 1000 live & stillbirths	Decrease of 59.2 deaths per 1000 live births	Decrease of 7.6 deaths per 1000 children 1-3 years	Decrease of 22.2 days of illness per child 0-3 years	Increase of 1.3 cm of height at 36 months of age	Increase of 5.2 percentage points by 36 mons. of age
Index**	100	100	100	100	100	100
NUTHC	94	81	70	100	92	100
NUT	100	55	100	0	100	56
HC	54	100	100	94	15	0

* Actual difference in rates or values in the most effective service package from control levels.

** For example, if the maximum effect on perinatal mortality is a decrease of 43.3/1000 then an index of 94 denotes a decrease of 43.3/1000 x 94/100 = 40.7/1000

Table 7.5

COST/EFFECTIVENESS RATIOS FOR THE THREE EXPERIMENTAL GROUPS
(Indices Created by Equating Lowest Cost in any Category to 1)

I (a) Cost[1] per death averted

	Perinatal		Infant		1-3 Year Old	
NUTHC	1.3	($ 9.85)	1.5	($37.35	3.3	($101.45)
NUT	1.0	($ 7.75)	1.4	($36.40)	2.3	($ 71.75)
HC	1.8	($14.15)	1.0	($25.35)	1.0	($ 30.65)

(b) Cost[2] per day of illness averted

	Infant		1-3 Year Old	
NUTHC	1.4	($ .56)	1.1	($ .39)
NUT	*		*	
HC	1.0	($ .40)	1.0	($ .35)

II (a) Cost[3] per additional cm growth at 36 months

NUTHC	1.0	($26.25)
NUT	1.2	($30.40)
HC	*	

(b) Cost[3] per additional percentage point increase in psychomotor development scores over the first three years of life

NUTHC	1.0	($ 5.05)
NUT	2.7	($13.60)
HC	*	

1 using a proportion of total program costs equal to the age specific mortality rate

2 using all health care costs minus costs counted under mortality

3 using all nutrition costs minus costs counted under mortality

* small or no effects produced large or infinite cost/effectiveness ratios.

The lowest cost/effectiveness ratios for deaths averted were $7.75, $9.85 and $14.15 for "prenatal child care" costs per perinatal death averted in NUT, NUTHC and HC experimental groups respectively. Costs per infant death averted were lowest in the HC experimental group of villages ($25). Using this figure as an index of 1.0, the other costs per infant death averted were 1.4 ($36) in NUT and 1.5 ($37) in NUTHC. As with infant deaths, the services in the HC villages were the most cost/effective in averting deaths in children 1-3 years of age ($31). NUT services were more than twice as costly per child death averted ($72) while NUTHC services were at least three times as costly ($101).

The number of days of illness due to nine selected symptoms (see Chapter 5) were used for the morbidity indicators. Tables 7.4 and 7.5 show that only villages with health care services produced any reduction in days of morbidity. In infants the cost per day of illness averted was $0.40 in HC villages and $0.56 in NUTHC villages. For children 1-3 years of age the costs were $0.35 and $0.39 respectively.

The NUTHC experimental group of villages had the best cost/effectiveness ratios for both growth indicators. Nutritional costs per additional centimeter of growth attained by 3 years of age in comparison to control was $26 in NUTHC and $30 in NUT villages. Costs per percentage point of increment in psychomotor scores was $5 for NUTHC villages, and $14 for NUT villages.

In conclusion, Table 7.5 shows that infant and 1-3 year mortality are decreased with the least cost by health care alone, but perinatal mortality is prevented for the least cost through nutrition services. To decrease morbidity, health care alone is the most cost/effective approach, but increases in growth and development are obtained for the least cost through

the combined program. Comparing Tables 7.4 and 7.5 it seems that children would benefit most through the combined program but at somewhat higher costs than either NUT or HC alone. The argument, therefore, for combined services at least in the Punjab context is that for only slightly more expenditure of time and money than for either one of the single intervention packages a definite impact can be achieved on physical growth and psychomotor development as well as mortality and morbidity.

CHAPTER 7 - References

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CHAPTER 8

POLICY AND PROGRAM IMPLICATIONS

Carl E. Taylor, Robert L. Parker and Cecile De Sweemer

Introduction

Current worldwide concern for basic human needs and social justice leads naturally to higher priority for primary health care[1,2]. Inequities which result in differential access to services require direct measures designated to meet the main health problems of those who have been deprived of entry into an appropriate health care system. The most important contribution of the Narangwal research is the hope that it offers that access to health services can efficiently and cost/effectively be extended to the poor. The types of services that evolved specifically eliminated prior inequities for those in greatest need.

The practical interventions tested in this research are especially relevant to world needs because about half of the child mortality and most of the growth retardation in developing countries is caused by synergism between malnutrition and common infections[3]. Programs to reduce such synergistic interactions would profoundly improve health status among the children of the poor. Our research refines understanding of the dynamics of the interacting variables that produce such synergism in human populations. More importantly, we have demonstrated ways in which nutrition and infection

control can be combined to produce synergism of programs to compensate for the synergism of problems.

In the past, improvement in the health and nutritional status of children occurred spontaneously as a result of general socioeconomic development. It is not necessary now to wait for general development since measures are available that contribute directly to improvement in quality of life of children. The process of implementing national programs obviously has to start with political commitment among national leaders. Decisions that lead to successful programs, however, require assurance that there is a technology and organizational framework which can be applied within the constraints of the financial and manpower resources available in any country. A selective approach is needed in health planning to put together appropriate combinations of interventions that will produce the greatest health and nutrition improvement at least cost. Careful adaptation of findings from this and similar research to the particular conditions of each country can provide such a technology and framework.

Policy Concerns Relating to Equity in Distribution and Intergration of Services

1. *Contribution to General Socioeconomic Development*

This project made no effort to study broad policy questions that have been the focus of most nutrition reports such as food production, pricing policy, marketing and distribution. Similarly, most demographic or health policy research has analyzed macrolevel population and program data in terms of general socio-cultural and economic factors or of specific

disease related influences. Even though these issues have not been the primary concern of this research, we recognize their importance in interpreting our results. We also showed that these programs did contribute to general attitudes toward development in these villages.

The rapid improvement in food production and economic level in the Punjab obviously influenced our findings. We started with the situation as we found it in Punjab villages and obtained considerable information about the socioeconomic status of households. In the analysis these were considered background variables and not variables that might be directly manipulated.

The situation in the Punjab challenges many current preconceptions about nutrition programs. The fact that more than 25 percent of children were malnourished in spite of massive food surpluses, meant that just providing more food would not be useful. We knew that in these Punjabi villages there was abundant food available in the community and therefore the problem was not one of increasing production at the macro level. It was clear that the usual types of feeding programs would be irrelevant because they tend not to be used by the most needy children who are too poor to go to school or unable to get to local feeding centers. In addition to the direct health and nutrition services that were provided solutions were sought through two types of social mechanisms.

First were measures to meet the obvious need for more equitable distribution. Many findings from this research demonstrate that malnutrition and poor health occurred mainly in socially and economically deprived families. Mechanisms at the community level to ensure equity in distribution had to be

developed specifically to focus nutritional and health care on high risk children. We disagree with the idealistic mythology that seems to assume that communities will automatically take care of their problems if just given resources. The reality is that just turning development activities over to communities as presently structured may simply strengthen local exploiters who are in positions of authority because they have most successfully gained control of community resources. One of the most important changes that occurs in the development process is that people begin to recognize that shared progress for the community as a whole is possible and that benefits for those who have will be jeopardized by continued deprivation of those who do not have. Cooperation becomes possible when the whole orientation is changed from a "zero-sum" view of the future which leads people in traditional communities to consider any benefit for one family to be at the expense of their neighbors[4]. Surveillance activities showed where the real problems were and focussed on mechanisms to encourage local leaders to understand that the whole community would benefit if better care reached everyone with special attention to those in greatest need. Although not focusing specifically on community development this project showed that integrated child care services can provide almost total coverage and can stimulate the enthusiastic and continuing support of the village leadership in promoting equity.

The second mechanism that produced a broad social impact was our deliberate educational effort to change family life styles and patterns of raising children. For instance, because there was a strong belief in the supernatural causation of severe marasmus, a dramatic recovery produced major changes in

people's view of the future and the potentials of change. Our main educational effort was through intensive one-to-one, service-based teaching of mothers. Mother-care is the most powerful force influencing the growth and survival of children. It is mothers, not doctors, who are the most important health care personnel around the world. The high prevalence of childhood malnutrition in Punjab villages was due mostly to poor feeding practices and the metabolic drain of common recurrent infections. Although our direct services intervened dramatically in reducing the impact of infections, the most important long term effect of the Narangwal project in these villages will probably be what was done to change general patterns of child care in the homes.

2. *Integration of Primary Child Care Services*

By testing the advantages and relative costs of combining various types of services we demonstated that integrated services produced greater overall benefits than separate services. At least six potential benefits from integration have been identified. In the present study only the first was not clearly documented.

First, we did not demonstrate for each of the outcome indicators the phenomenon that is usually defined as synergism when the combined influence of two factors is greater than the sum of their separate effects. Except in the case of psychomotor development, combined services were usually not even additive in producing a greater impact on any parameter measured than was produced by a single services alone. For most specific indicators, single-purpose services produced an equivalent or slightly greater impact than combined services. The apparent lack of synergistic effect may be partly due to the fact that by all socioeconomic and health indicators the combined care villages

had the worst initial health and nutritional status and environmental conditions and final comparisons were made between service groups and not in their relative improvement.

Second, to get a holistic perspective on synergism as a combined program effect on health rather than in relation to specific outcome measurements it is necessary to modify the usual definition of synergism. When combined effects are measured in terms of a single outcome (i.e., either growth, mortality or morbidity) quantitative definition is possible. To estimate overall impact on health it is necessary, however, to speak in qualitative terms because we have found no way of quantifying the equivalence of deaths to days of illness to growth measurements. Conceptually, however, it is clear that the combined services produced almost as much impact on mortality and morbidity as health care alone and also almost as much effect on growth as nutrition alone and the total effect on health is therefore greater than either of the separate services.

Third, integration was justified in terms of efficient use of resources because the combined cost of nutrition and infection control program elements in NUTHC villages was less than the sum of individual costs in NUT and HC.

Fourth, the project demonstrated the possibility of efficient organization in defining the responsibilities of peripheral primary care workers. It was possible to train family health workers (FHW's) to carry out the whole range of combined activities with little more effort than for a more limited range of tasks. Our experience in other situations suggests that it may be harder to retrain a single purpose worker to become a multipurpose worker than it is to train them from the beginning to undertake integrated tasks.

It is possible for training to be increased incrementally and work responsibility expanded, but for such a system to succeed it must be planned from the beginning so that workers are prepared psychologically to accept wider responsibilities. Since much of the program depended on home visiting, efficiency was greatly increased by scheduling activities so that one visit could be used to carry out several functions. Standard rosters were developed to facilitate such scheduling. Similarly, appropriate combinations of activities prevented duplication of supplies, facilities, transportation, supervision and other logistic variables.

The fifth reason for integration is that the long range rapport and acceptance needed for effective community participation may be achieved most permanently through programs which address multiple concerns. Since health and nutrition are both important in the minds of the people, the combined services generated greater social support. High demand for immediate care increased the acceptability of other activities about which people were ambivalent. One of the reasons for the remarkably high level of cooperation with health surveillance and preventive activities and with family planning was that village people trusted FHW's completely because of rapport created through curative work.

Finally, quality of work obviously depends on worker satisfaction and this was greater with a "balanced" mix of health activities including direct patient responsibility. When we first started field activities we were aware that the sheer numbers of ill children, the concerns of parents and the status attached to successful healers might influence family health workers to pay attention primarily to curative work and neglect noncurative activities. To forestall such a situation preventive and surveillance tasks were emphasized

in the continuing education program, in village meetings, during supervisory visits and especially through a record system that included appropriate reminders of scheduled tasks. Through careful training, supervision, and recognition for balanced achievement family health workers accepted the need for such activities as organizing immunization rounds, establishing the practice of home treatment for diarrhea, educating mothers to prolong breast-feeding, and collecting routine surveillance data. They did, however, express continuing reluctance to work in either of the two control villages where their tasks were limited essentially to data collection and the simplest symptomatic care.

Applications of Research Findings

The two major purposes of this research outlined in Chapter 2 were to answer specific research questions and to define pragmatic field interventions to be implemented in regular programs. In Chapter 1 the detailed quantitative findings relating to the first set of specific research objectives are summarized. This section presents some practical applications of these research findings which are based on comparisons of the service packages used in experimental groups of villages. These program effects are presented according to types of services provided.

1. *Prenatal and Perinatal Child Care*

An effective means of reducing mortality of babies at minimal cost in our study population was prenatal care, nutritional education and nutritional supplementation for pregnant mothers. The FHW provided health and nutrition advice and iron and folic acid for all women from the time that

pregnancy was diagnosed. In addition, caloric supplementation was given to selected poor mothers in clear nutritional need. These relatively simple interventions had a dramatic overall effect because of the high prevalence of nutritional anemia in women and children and low average birth weights (<2500 gms) in this population.

Almost as dramatic a means of reducing mortality at low cost was the control of neonatal tetanus. In the Khanna Study in nearby villages ten years earlier this complication of poor care of the umbilical stump at the time of delivery was the fourth cause of death overall in total mortality[5]. Our activities concentrated on two approaches. An immediate effect was achieved when women were immunized with tetanus toxoid in order to provide their babies with protective antibodies. We were able to get evidence that immunizing all women in reproductive ages with a single dose of a new tetanus toxoid resulted in antibody responses that should provide adequate protection to their offspring.

A somewhat slower approach was to train dais (indigenous midwives) to use aseptic techniques in cutting, tying and dressing the umbilical stump. Education of dais also included general obstetrical care during delivery to protect the baby as well as the mother from unnecessary trauma, a major cause of perinatal deaths. A program to develop good surveillance techniques for identification and early referral of mothers at risk was a part of the parallel population program[6]. Surveillance techniques involving both dais and FHW's were being progressively improved but required much time and patience.

2. *Medical and Infectious Disease Control Components of Child Care*

The most straightforward approach to prevention of infections is

through immunization. We had an effective program for immunizing against common childhood diseases but none of these conditions were sufficiently prevalent during the study period to show measurable impact.

Another approach to the prevention of infections is sanitation. We did not include such activities in this study. Punjab villages already had a handpump in almost every home - for convenience rather than health reasons. There was no simple way to further improve water supplies significantly. Many years of health work in Punjab villages had convinced us that getting utilization of latrines and improving general hygiene would require a long-term effort. The only such activities that we promoted in this project was education about cleanliness in child care. Obviously in a general health care program such activities should have an appropriate place.

The most effective infection control measure in this project was a continuing program for morbidity surveillance that provided early diagnosis and treatment of common infections. The conditions of greatest concern were common conditions such as simple diarrhea, respiratory infections and skin and eye infections. The first two are the major killers in village children in combination with malnutrition and the later has been a significant cause of blindness. Our program was not designed to reduce incidence of these common infections except through general education about hygienic practices. However, a major finding of this study was the demonstration that efficient surveillance, early diagnosis and simple treatment by auxiliaries sharply reduced both mortality and the duration of morbidity. The family health workers independently diagnosed and treated 90-95 percent of health problems. Their effectiveness depended largely on a regular system of supportive supervision

with weekly visits by a physician and a public health nurse. Special emphasis was placed on training sessions every two weeks in which field and supervisory staff worked out problems together, reviewed skills and developed new competence

Establishing simple methods of controlling major disease problems does not happen automatically as we learned in the special activities to reduce mortality from diarrhea and pneumonia which are described in Chapter 7. At the start we had to work within the official policy that the best care could be provided by referring acutely ill children to the doctor in the health center rather than having auxiliaries treat such children immediately at home. Systematic efforts to change practices started only after careful monitoring of the causes of mortality identified diarrhea and pneumonia as being responsible for 60 percent of child deaths. In group discussions practical measures for shifting care to the home were worked out. Family health workers were intensively trained and supervised to carry out these measures and experienced a great sense of satisfaction in being able to initiate effective treatment themselves.

The simple measure that proved most effective in controlling diarrhea mortality was early and consistent oral rehydration. The biggest problem in getting this accepted was that it seemed too simple both to our physicians and to FHW's. They had been trained to assume that the right way to treat dehydration was to refer patients to a health center for intravenous rehydration. A cultural constraint that added to the difficulty was the common tradition that all fluids were stopped when diarrhea occurred because it was correctly observed that fluids exacerbated the diarrhea. One experience that helped in changing attitudes was that, as part of the concentrated training

effort, FHW's sometimes personally stayed for hours in the homes giving oral rehydration to demonstrate that even though the diarrhea was continuing, babies were improving. As a result of this special attention mothers learned to start oral rehydration on their own even before notifying the FHW. We closed the special rehydration unit in the health center because the few cases that still needed intravenous fluids could be handled by the regular health center staff and facilities.

The problem with lower respiratory infections and pneumonia was basically similar since analysis of time sequences showed that the main need was for immediate treatment. In this instance, however, it was assumed that giving a penicillin injection before the patient had been seen by a doctor was beyond the capability of the FHW. We got official permission to test as a research question whether the hazards from prompt treatment would not be less than continuing to leave cases untreated. New standing orders were established permitting FHW's to initiate penicillin treatment with arrangements for physician referral thereafter. The FHW's became remarkably adept at diagnosing pneumonia relying mostly on the baby's patterns of respiration and fever. Under our supervisory system they did not over-use the treatment and tended to be more conservative than physicians.

A final practical lesson relates to the intensity of morbidity surveillance at different ages. The maximum drop in infant mortality occurred in villages where FHW's visited every infant approximately every week. At this age illnesses had to be monitored frequently to get care started promptly. By contrast the frequency of monitoring used in comprehensive child care villages of the parallel population project (one home visit every one to

three months depending on age) proved less effective in reducing infant deaths. This longer interval was, however, fully effective in reducing 1-3 year mortality. Since it will usually be difficult in developing countries to set up a system where health workers can make weekly home visits, attention should be given to training village volunteers and mothers to carry out the simple type of illness monitoring needed to screen infants for serious illness. In a long term program they could initiate simple care such as oral rehydration and bring the child to a subcenter when illness is more severe. The surveillance procedures were found to have a powerful educational impact and could be readily included in programs of community involvement.

3. *Nutritional Components of Child Care*

As with morbidity the central activity in the nutrition program was systematic surveillance to monitor nutritional status. World-wide experience with road-to-health cards for recording weight gain has been reinforced by experience at Narangwal showing that it is possible to help mothers learn that a child with faltering growth is a sick child. Growth monitoring therefore served both as an educational device and as the principal entry point for active nutritional supplementation.

At the start of the project we decided against trying to provide supplementation to all children in the villages. It was obvious that mere provision of food was not needed because we were in a food surplus area. However, up to a third of children were malnourished. An analysis of risk factors showed underlying inter- and intra-familial maldistribution related to measurable socioeconomic variables. The surveillance methods made it possible to focus nutrition care on children with nutritional deficiency.

In many nutrition programs great amounts of money and effort go into feeding well nourished children while those in nutritional need remain unattended. The expense of monitoring weight and height can be easily justified because this makes possible the great savings that occur when food supplements do not get diverted to those in no need. The long term objective should be to start a continuing educational process so that mothers and community members would themselves learn to make consistent use of relatively simple surveillance measures such as regular weighing of children.

In a judgement that is more intuitive than data-based it is our belief that the most important long term impact from our nutrition program was in the education of mothers. The nutrition problems in the Punjab result mainly from inappropriate feeding practices and the heavy load of infections. Our results showed that it is a fallacy to assume that if food supplies are sufficient in a village, people will solve their own nutrition problems. In most developing countries, just as important as improving food supplies, is the need for a major effort to help mothers learn how to make better use of food. Much of the childhood malnutrition could be ameliorated by nutrients that are already available in the village. The nutrition education activities that had the most positive effect seemed to result from person-to-person contact. This occurred most naturally when FHW's and mothers were working together on a problem such as adapting the content of weaning foods to sharp seasonal shifts in availability in homes.

On a sample of children a detailed dietary analysis was done to provide information on the nutritional benefits that can be expected from different dietary intakes. Levels of dietary intake were defined below which optimum

growth did not occur in children. These levels were higher than FAO and other current standards probably because of the high prevalence of infectious diseases.

As with rehydration for diarrhea and penicillin treatment for pneumonia the definitive change in nutritional care of marasmus occurred as a result of progressive shifting of activities from the health center to the village feeding center and to the home. When the project started we established a nutritional rehabilitation unit at the Narangwal teaching health center which was specially staffed to provide intensive care for extreme marasmus (below 50 percent weight for age and not improving with home treatment). We eventually found that children who had become marasmic as a result of illness, poor weaning practices or parental neglect because of large families or being busy during harvest season, were rehabilitated most effectively by adjusting conditions in their homes or arranging for regular attendance at a nearby village feeding center staffed by village women. This avoided the anxiety, fear, time loss and cost associated with hospitalization at the health center. As with the rehydration center, we were very soon able to close the nutritional rehabilitation unit because it was no longer needed after the full village program was effectively implemented and few, if any, children were under 50 percent weight for age.

One of the most positive achievements of nutrition education was prolongation of breast-feeding. Average duration of breast-feeding in nutrition care villages was extended by five months, from 15 months to 20 months. A somewhat complex educational message had to be transmitted, to start supplementation with weaning foods at the sixth month but then to maintain breast-

feeding as long as possible because this maintains the protein content in the child's diet.

In educating mothers about weaning foods we faced the usual problem that families in developing countries customarily start children directly on adult diets. An infant would normally be handed a piece of chappati (unleavened coarse wheat bread) to chew on. A major reason is the lack of fuel and time to make special preparations just for children. Therefore, simple methods of preparation needed to be evolved such as not putting spices in the dal (lentils) until some had been taken out to be added to the child's weaning food of wheat gruel. Such procedures obviously need to be adapted to local situations and available foods.

Practical Evolution of Program Packages

In addition to the results relating to specific research objectives summarized in Chapter 1, this project had a parallel set of objectives for practical program development. In order to have discrete program packages which would serve as the experimental inputs into the cells of the research design it was necessary to evolve optimum sets of activities under field conditions. Each set of activities was designed to make the maximum impact through particular combinations of health care and nutrition intervention. Integration was carefully worked out to be much more than a simple juxtaposition of activities since great effort went into working out the combinations of services that were not only most efficient but provided services to those at highest risk. Through getting involvement of all field staff in identifying problems early plus rapid feedback to work out solutions together, we learned

a great deal about how a practical program can be implemented. The conclusions described in this section are based more on field experience than detailed analysis of data.

1. *Balancing Epidemiologically Determined Need Against Community Demand*

Local services must evolve from sound epidemiological understanding of local patterns of illness. As indicated repeatedly in this report, we found it especially important to set up a series of surveillance systems with simple indices and rapid feedback for program improvement. Too many services are planned centrally without flexibility to adjust to local conditions. To be effective, a health care program should be dynamic in shifting from one priority need to the next as conditions improve. To have such an innovative approach staff need to develop the capacity at the local level to use simple epidemiologic methods to make a community diagnosis. This should include definition of local causal factors and the ability to identify the most cost/effective interventions under specific conditions. Balanced against this epidemiologically determined definition of need there should be a parallel process of responding to community demand. Creating community capacity to express demand, especially among the poorest people in greatest need may be difficult. By responding to their immediate concerns, often for curative care, it is usually possible to generate interest and cooperation in collaborative efforts to express their underlying concerns. They will then be more likely to help in getting continuing information for epidemiological analysis and the initiation of appropriate preventive activities.

2. *Grouping Interventions According to Functions Rather than Disciplines*

Development of service packages involves selection of interventions

that are: focussed on local priority problems adapted to cultural constraints and convenience of the people, and grouped so as to encourage program implementation. In most health programs grouping of activities follows the disciplines of the specialists involved. For instance, nutrition activities are developed in accordance with what nutrition experts feel comfortable in doing, medical care has to fit doctors' preconceptions derived from hospital practice and immunization programs are planned for infection control specialists even though the vaccines may differ greatly in target ages, routes of administration, location of service and cold chain requirements.

We found that a more appropriate approach is to start by conceptualizing the functions to be performed. The grouping of the half dozen or so important interventions should be clustered according to the convenience of patients and where the functions can be best performed. For example, activities that require surveillance through home visiting can be worked out to fit together whether they relate to nutrition, infection control or treatment. Similarly, functional categories such as clinic care, education, mass immunization campaigns, and supportive activities should be integrated mainly according to what makes sense to patients.

3. *Selection of Auxiliaries*

A complex but important principle relates to selection of the auxiliary workers who will provide most of the primary health care. It is necessary to fit into whatever national manpower pattern has been established in order to facilitate training, licensure and subsequent job openings. At Narangwal the peripheral workers we retrained as FHW's had to have a high performance level because of the research needs of the project. We decided

on lady health visitors and auxiliary nurse midwives because they were already serving as regular staff in primary health centers and subcenters and retrained them to fit their new roles in the project. We used part-time community workers mainly in nutrition activities. We encountered serious resistance to sending family health workers to work in their home villages because the strong factions (pattis) in North Indian villages make it very difficult for workers to cross faction lines in their own villages. Therefore, in North Indian villages one option that may have to be considered in implementing the national community health worker program is to have a part-time CHW for each of the two or three factions in a village.

As a follow-up of the Narangwal experience, we showed in the Companiganj Project in Noakhali District, Bangladesh, that a much simpler service program could effectively use community workers as the principal providers of care[7]. These village women were often illiterate but still extremely capable. Similar results with community workers have more recently been achieved by several demonstration projects such as at Jamkhed[8], Kasa[9], Dhokwade/Uran[10] and Vadu[11].

4. *Supportive Supervision and In-Service Education*

Especially important for morale was a systematic approach to combining supervision with in-service education. This required intensive reorientation of physicians and public health nurses for a new type of supervisory role. Doctors had to learn that when they went as consultants to a village subcenter they were not to take over and subordinate the FHW into serving as an assistant. Instead they were expected to work through the FHW and support and strengthen her. The frequently reiterated slogan was that after a supervisory visit the capability, self-confidence and prestige

of the FHW should be greater than before.

For in-service education of FHW's we depended mainly on a general training day every two weeks when all staff were brought together to review problems and search for solutions. They told us what was or was not working and together we developed better approaches. Sessions were organized around current problems in the field.

5. *Size of Population Covered*

We learned a great deal about what is a reasonable population load for a primary care auxiliary to cover. Although these services concentrated only on children, it seems possible to extrapolate our carefully recorded experience to what would be a reasonable overall work load in government services. Numbers will obviously have to be adjusted according to whether or not village homes are conveniently clustered for easy visiting as in the Punjab. A greater dispersion of population will obviously make it necessary to reduce numbers in the coverage load and to consider using more part time workers from the community.

Our FHW's were able to provide comprehensive care for an average of about 100 children. Because at least half of their activities were devoted to research functions they probably could have care for about 200 children under three years of age in a purely service setting. Since child care is one of the largest components of total primary care, we estimate from this experience that an auxiliary could provide total coverage for a population of over 2,000 under Punjab conditions. This can be increased to the current goal of national health services in India, of one multipurpose worker for 5,000 population, by making much more use of community workers and eliminating some components of the services.

6. *Use of Other Sources of Care*

When effective new services were introduced into study villages it was shown that they rapidly became accepted and utilized heavily by the community. In comparison with control villages the number of ill children going untreated in study villages was reduced from 60 percent to less than 20 percent. The use of other sources of care was diminished but continued at significant levels in all villages. The fact that there was a persistent trust in local practitioners, whether qualified or unqualified, supports the usefulness of programs to upgrade the competence of rural health practitioners as an adjunct to well-organized village level services staffed by auxiliary workers. The need for selective retraining of rural practitioners has been documented in a recent report[12]. A review of mortality data in the Narangwal area revealed that the majority of deaths due to dehydration associated with diarrhea was in children who received inappropriate treatment from both unlicensed and licensed private practitioners.

As mentioned earlier, even in villages in which FHW's were active the use of other sources of care continued and expenditures on them were far from negligible. Accordingly, we met with local indigenous practitioners individually and on occasion brought groups of practitioners to the project headquarters to explain what we were doing, to get their cooperation, and to try to neutralize the negative rumors about project services that were occasionally started. We worked even more with dais to make them feel that they were members of the health team but only about half of the dais chose to cooperate. In a separate project we conducted detailed studies of their practice patterns and classified their activities according to whether they

were beneficial, neutral or harmful. We then began to develop methods to teach them to change those activities that were harmful.

7. *Costs*

In absolute terms the costs of providing nutrition and health services to children under three in the Narangwal nutrition project were about Rs 150 ($19.5) per child or Rs 14 ($1.8) per capita per year (about Rs 7 or $.90 per capita if government economies of scale could be realized). Since the costs per service contact were quite similar to government primary health center costs per contact the difference in total costs between Narangwal services and current government services was due to the much greater frequency of contact in the Narangwal project. Differences in mortality and health indicators amply demonstrated the effectiveness of the intensive Narangwal services in comparison with control villages which had access only to private and government services. However, considerations of equity as well as political and economic realities would seem to dictate spreading currently available government health resources over total populations rather than concentrating on particular villages. Since there is probably a threshold beyond which spreading the coverage of services would seriously compromise effectiveness, rational health planning has to address the inevitable balance between equitable coverage and signficant impact of services.

For eventual implementation of mass child health and nutrition programs it would seem appropriate to explore alternatives to past national plans which promised free medical care to all, but actually reached only a fraction of the population. An example of such an alternative which might produce maximum impact on child health would be to have communities pay for more of

the costs of care. The primary health centers could then focus their limited funds on preventive services, surveillance, and early treatment. The primarily symptomatic curative services which people are already paying for privately could be provided on a pre-payment or insurance basis.

As mentioned above, the most important and feasible saving in personnel costs would be to train village people to take more responsibility for their own health care. Especially in surveillance many of the tasks are relatively simple and repetitive. For example, weighing of infants and children on a routine basis could be handled by village volunteers. Similarly, simple morbidity surveillance could become a community responsibility.

8. *Community Participation*

Although it was not a major research objective, the Narangwal study produced some information about ways to promote community participation. In WHO terminology, Primary Health Care differs from Basic Health Services in that it not only builds up the peripheral components of the health system, but also includes a major emphasis on promoting community participation and the involvement of other development sectors such as education, agriculture, etc.

Primary health care includes all activities at the interface between the community and the health system. In this research we concentrated mainly on the health system at subcenter level but we also gained some practical experience in promoting community involvement. For instance, there was little porblem in getting villages to provide buildings for sub-centers. Usually a part of a home was adapted for the purpose and this proved highly acceptable culturally. This suggests that the current emphasis among international agencies on building facilities may be misplaced. Putting money

into new buildings which are more elaborate than village homes carries the implication for community workers that their most important work will be in the sub-center rather than in the home and community. In the Punjab ecology home visiting proved especially effective in reducing infant mortality. A high level of motivation and felt need seemed to be necessary to get mothers to leave homes with their children so that the preventive and educational activities that seemed to have the greatest health impact had to be taken to village homes on a frequent and continuing basis. It was evident that the most effective way to discourage the FHW's from walking village streets and visiting the homes of the poor was to provide them with an excuse to sit behind a desk in a comfortable building filling out forms. It is our impression that this tendency will be true in most rural services in developing countries.

Another activity in which it was relatively easy to get community participation was in providing food for the feeding centers. Providing food proved to be the single most expensive part of the combined services. Again, food has been a favorite item for international assistance. We became concerned about the tendency to create dependency on outside food resources and in the latter part of the project began to explore the possibilities of developing among land holding farmers an awareness of their responsibility to help meet the needs of the landless. The most tangible evidence of community participation occurred when feeding center supplies were delayed and community leaders went around at harvest time to get donations of food from farmers for the supplementation program. This was relatively easy in the food surplus Punjab where it became a matter of community pride. Our experience suggests, however, that much more could be done even in poorer communities. An approach that has worked in projects such as at Jamkhed in South India[13] is to get the village to put aside land on which they cooperatively grow food to provide nutrition supplements

for those in greatest need.

Along with promoting community participation it is also important to get individual families to take pride in and responsibility for maintaining adequate levels of nutrition in their children. In cases of malnutrition, individualized nutrition education to families focussed on getting them to provide the necessary weaning foods so that their children would return to expected nutrition levels. The whole surveillance of weight concept is built on the principle that making parents conscious of patterns of growth will help them to identify faltering of growth as an illness and will encourage them to take early and appropriate nutritional action.

A third instructive experience in community involvement was the development of day care centers. The finding that much of the child mortality was concentrated during the harvest season in May and June led to careful definition of the specific causes. The principal cause of death was severe dehydration resulting from a combination of high prevalence of diarrhea, extremely hot weather, and greatly reduced parental care because everyone was busy with harvest activities. These problems were most severe among the poorest agricultural laborers whose greatest priority had to be concentrated on long hours of work to get the year's supply of food. Setting up day care centers generated cooperation in providing facilities, equipment and volunteer labor. It was apparent, however, that the organization of these activities and the process of making them useful for nutrition education depended largely on considerable effort by the FHW assigned to a village and other project staff.

We found that services provided through a well-organized, cost/effective integrated program of auxiliary-based services is feasible and greatly improved coverage and equity. It is not sufficient, however. Self-help

within the family, committed community participation, effective involvement of indigenous health care providers, and intersectoral cooperation are likewise important.

9. *Relation to Population Growth*

Prospects for long term development in a country depend on maintaining a balance between the number of people and resources. The interactions between mortality and fertility are two-way. Family planning is clearly one of the most important and readily available health measures both for mothers and children. In fact, after all the efforts reported here there continued to be 15 to 25 percent of children with malnutrition in these villages, mostly female children with high-parity mothers. Our impression is that malnutrition in these villages will be eliminated only when family planning is widely practiced.

Conversely, it is increasingly evident that improved child health can have both direct service and indirect motivational effects on increasing family planning practice. One of the most important elements in this motivational change seems to be that improved health and expectation of longer life for children can have a powerful influence on parents' views of the future. This in turn may affect their attitudes to change, progress and hard work. A parallel population study at Narangwal explored in depth the interrelated ways in which health services improved family planning[14]. Among the health measures the reciprocal relationships between family planning and child care emerged as an important factor which strengthens the practical significance of the research reported in this volume.

Process of Moving from Field Research to Program Implementation

The Narangwal experience has contributed to understanding of how health

services research can directly influence program planning and implementation. The evolution of new patterns of integrated nutrition, health and family planning services has become such an urgent problem for developing countries that rapid progress toward effective implementation has high priority. Most countries are moving ahead with implementing what is known now, and that is appropriate since implementation of current knowledge should never be postponed while waiting for more research. There is nothing so wasteful, however, as a mass program designed on the basis of experience elsewhere which does not fit local conditions. Trial and error is a useful approach for minor incremental change but usually not for large scale innovations.

Far greater efficiency can be achieved by having research and demonstration projects linked closely and in parallel with a general program of implementation. We devoted great effort to maintaining constant communication with health administrators at Central and State level and showed that new ideas can be tried out and adapted in concurrent health services research with rapid feedback to general services. Through the years many of the policy changes that have occurred in India came directly from rapid feedback from research projects such as Narangwal. Good field research can facilitate public acceptance of innovations for general implementation.

A spectrum of project types is required in a country such as India. A few centers are needed where detailed health services research of the type undertaken at Narangwal is carried out. Basic problems can be studied but recognition is needed that research costs may be substantial when compared to routine services. Findings from such research need to be adapted in demonstration projects to different local conditions and working arrangements

where inputs should be close to anticipated program costs in general services. These demonstration projects can be used as training bases for preparing field workers as part of phased implementation in general services. It is possible to convince health workers through field visits and workshops that the new approaches are feasible and within their capability. Repeatedly at Narangwal visitors to the project left saying something to the effect, "the greatest thing I have learned is to see that it is possible for me to change how I provide health care and that these new methods really do make a difference."

Prospects for Future Programs

The ultimate message of the Narangwal Nutrition Study is one of hope. We have shown that simple methods of infection control can reduce the duration of infectious disease morbidity, reduce infant and 1-3 year old child mortality and produce moderate increases in growth for all the children living under normal village conditions. We have also shown that highly focussed nutrition care will significantly increase growth and psychomotor indices and reduce 1-3 year old child mortality. Perinatal mortality was reduced by prenatal care for mothers, especially through universal provision of iron and folic acid selected supplementation of high risk mothers, health and nutrition education, appropriate cord care and tetanus toxoid immunization.

Integration of services was shown to be the most efficient and effective approach because it produced all of the benefits of both single-purpose programs but for much less than the combined costs of these separate programs. Multiple additional reasons for integrating services included worker productivity, public rapport and long range educational effectiveness. In designing these

programs, it became clear that professionals must give up their habit of structuring field activities according to their own disciplinary orientation. Instead, functional packages need to be developed that fit the cultural sense and convenience of villagers, that address high priority problems and that promote the efficiency of workers at the interface btweeen the community and the health system.

All of these benefits in child health were achieved by simple methods, with over 90 percent of the care being provided by family health workers. The total cost for comprehensive nutrition and child care was less than $2 per capita (total population) per year.

These activities can be structured so as to ensure coverage of the poorest and most needy segments of rural populations. They have great potential in promoting continuing participation of the village people, especially mothers.

To apply these findings to local situations in other places will require careful field adaptation through special demonstration projects. This research provides a practical basis for a combined attack on the synergism between malnutrition and infections. Improving the mortality, morbidity, and growth and development of children can be a tangible and rapidly implementable component of a general development process designed to promote directly the quality of life of village people.

CHAPTER 8 - REFERENCES

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